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Former and Modern Bridge Construction, Queensland

An interesting contrast is afforded by the two photographs herewith showing bridges in Queensland, Australia. The two bridges are not very far apart; both cross Alligator Creek. The lower one, a highway bridge, was built about 40 years ago; it has a span of some 120 ft. Each main pier is formed by a three-bent trestle tower made up of ten piles. The structure itself is of the Bollman type, of which some exampies still exist in America. Another remarkable feature of the bridge is that it is below extreme flood level, but it is submerged only by backwater.

The railway bridge, built two years ago, has three spans of 110 ft. While the steelwork is in some respects peculiar from the American viewpoint, the most interesting feature is the concrete trestle-tower construction with concrete-embedded diagonal braces.

TWO QUEENSLAND BRIDGES

The City Tunnel of the Catskill Aqueduct

By Walter E. Spear*

SYNOPSIS—This tunnel will ultimately deliver 500 millions of gallons daily, through uptake shafts, to the great arterial water mains of the city, connecting with Richmond Borough by means of a submerged pipe line beneath The Narrows. The tunnel proper is 17.7 miles long and from 15 to 11 ft. in diameter. Its depth in some places is 700 to 800 ft. below the surface of the ground, and it is never less than 150 ft. below the surface of sound rock. The general plan of the tunnel and work preliminary to its construction were outlined in Part I, Engineering News, Jan. 14, 1915. The present article describes the construction of the shafts, both in earth and in rock, including reinforced-concrete shafts and air locks required at a number of points. Valuable tabular data are given.

II. Construction of Shafts

The construction of the City Tunnel has proceeded steadily since the work was let early in June, 1911. The reader is referred to the Construction News section of Engineering News, of May 18, 1911, for the canvass of bids and the amounts estimated for the work by the low bidders, to whom the contracts were awarded. The last shaft was sunk and headings turned in February, 1913. The tunnel is now completely driven and lined. The final concreting of the waterways and valve chambers is under way, but few shafts have yet been completed, and the limits of this article do not permit of a detailed description of the many interesting features of this portion of the work.

The difficulties freely predicted for the undertaking, before the work was started, have not been realized. Indeed, the conditions affecting the progress of the work, such as the character of the rock and the amount of water encountered, have been found to be, on the whole, more favorable than anticipated even by those most familiar with the preliminary investigations. Between the tunnel itself and the 24 shafts which had first to be excavated, the latter offered the greater difficulties, inasmuch as many of the shafts had to be sunk some depths through the loose water-bearing sands and gravels of the drift deposits, and all had to be excavated through the broken and decayed surface rock, where water was frequently encountered, while the tunnel was driven at considerable depths in generally sound, dry rock.

Shafts in Earth—With the exception of Shaft 7, where an open caisson of reinforced concrete was sunk to bedrock, the first 18 shafts were excavated in earth without difficulty by ordinary open-cut methods. The excavation at the surface for the large masonry valve chambers was generally made before sinking the shafts. In order to prevent any loss of ground about Shaft 5, at 183rd St., which was excavated beside the old Croton Aqueduct, steel piling was used to reach the rock about 30 ft. below the surface, and the excavation for Shaft 18 on Broadway at 24th St., which is near many important substructures, was similarly made within steel sheeting.

The earth portions of the last six shafts, Nos. 19 to 24 inclusive, presented, however, unusual difficulties, because the rock at these shafts in lower Manhattan and in Brooklyn was from 63 to 148 ft. below the surface of the ground, including 40 to 108 ft. of wet ground, all in locations where it was unsafe, by reason of adjacent buildings, elevated railroads, subway and other subsurface structures, to excavate by other than pneumatic methods. Reinforced-concrete caissons were accordingly sunk under compressed air and sealed off in the rock before the excavation of the rock shafts by free-air methods was begun. The general design of the concrete caissons at Shafts 19, 20, 22, 23 and 24, and the method of sinking are indicated in Fig. 5. The V-shaped steel cutting edge was first set up on the bottom of the chamber excavation, 1:2:4 gravel concrete added in 5-ft. lifts, and the caisson sunk by its own weight until the groundwater was reached, when special reinforcing rods for the deck, which were hooked around the main reinforcement, were bent out, the deck above a 6- to 7-ft. working chamber concreted, the steel shafting and locks erected, the caisson loaded with sand and pig iron, and the sinking under compressed air begun. Except for the caisson at Shaft 19, where only one

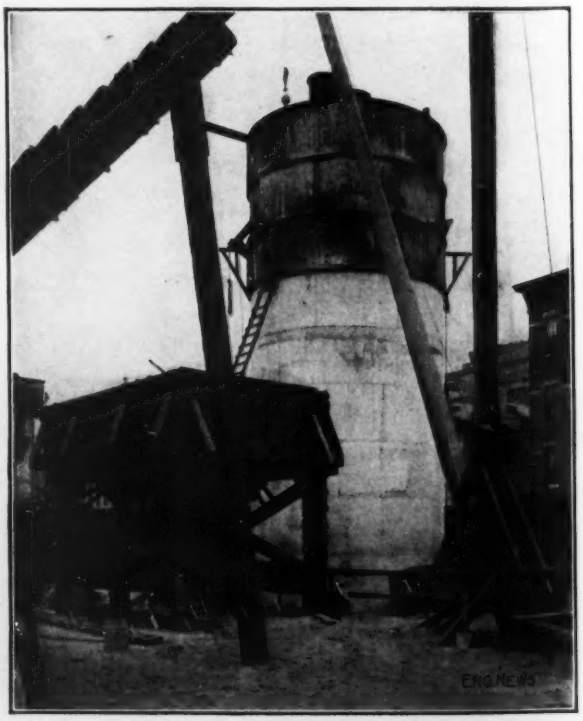

Fig. 4. Caisson at Shaft 22, with Outside Forms and Locks in Place

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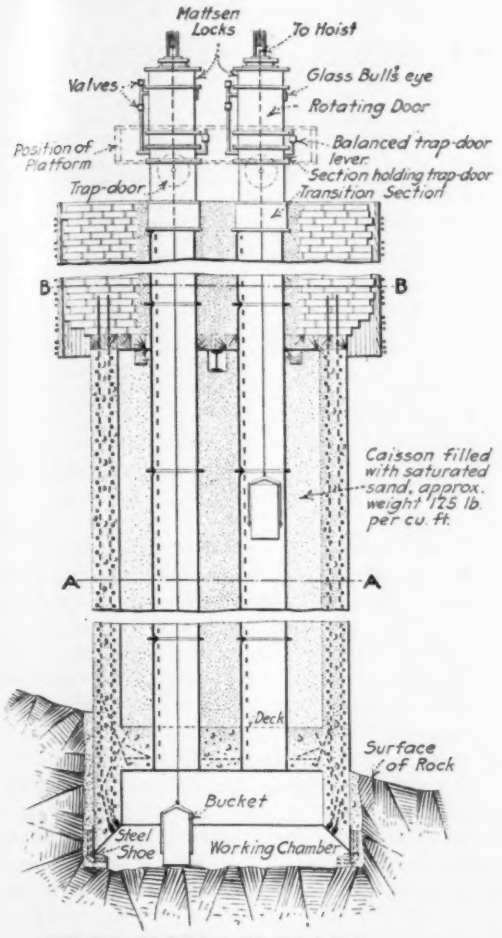
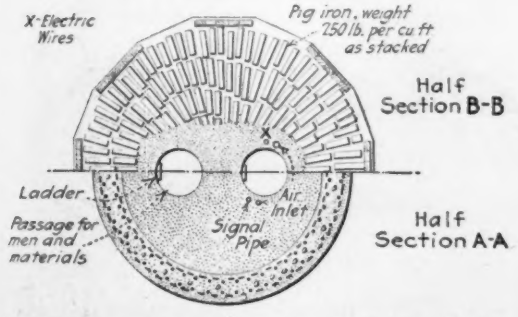
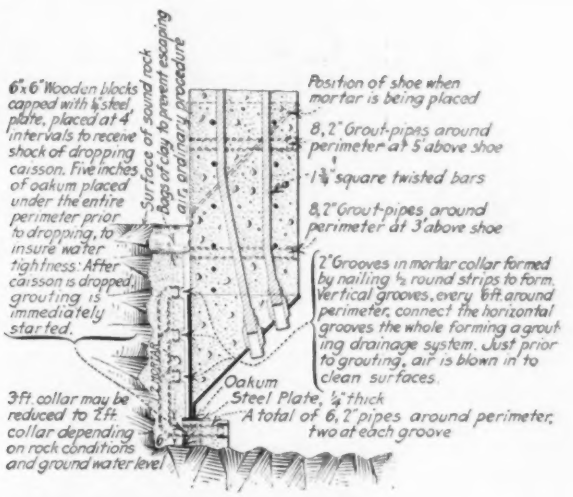


TYPICAL SECTION OF CAISSON



shaft was necessary, each caisson had two shafts, which on the shallower caissons were both 3 ft. in diameter, of ¼-in. riveted steel, with ladder recess, and provided with Mattsen locks 3.33 ft. in diameter. One of the shafts on the caissons at Shafts 22 and 24, and both at Shaft 23, were of similar construction but 4 ft. in diameter, with locks correspondingly large. One of these lines of shafting at Shaft 23 collapsed during the sinking, while the air pressure was temporarily removed, and both lines were then reinforced outside by 12 in. of concrete to a height of about 100 ft. above the deck. A photograph of the caisson at Shaft 22, showing outside forms and the locks in place, is seen in Fig. 4.

In order to effect as tight a seal as possible at the rock surface, the caissons were sunk from 2 to 5 ft. below the lowest point of rock around the cutting edge and concreted, as shown in Fig. 5. This method was highly successful, as the leakage from the seal, after taking off the air, was only 7 gal. per min. at the deepest caisson, that at Shaft 23, where the hydrostatic head was over 100 ft., and this leakage was subsequently all grouted off. The leakage was only 3.4 gal. per min. at Shaft 24 when the compressed air was first removed, and less than 1 gal. per min. at the others. The necessity for sealing these caissons into the rock made the compressed-air work more than ordinarily difficult and arduous, since it required from two to three weeks to excavate the rock and make the seal, and the highest air pressure was necessarily maintained during this period. The rods in the outer of two rows of vertical reinforcing rods in each caisson were subsequently connected by sleeve nuts to other rods concreted into the outer lining, and the rods of the inner row will be similarly joined to rods placed in the concrete plug, filling the solid rock shaft below the caisson. The purpose of these rods is to resist overturning of the caisson and thus prevent the rupture of the waterways, should a deep excavation be made beside the shaft without providing for the unbalanced earth pressure on the caisson.


6"x6" Wooden blocks capped with ½ steel plate, placed at 4' intervals to receive shock of dropping caisson. Five inches of oakum placed under the entire perimeter prior to dropping, to insure water tightness. After caisson is dropped, grouting is immediately started.
Surface of sound rock
Bag of clay to prevent escaping air, ordinary procedure
Position of shoe when mortar is being placed
8, 2" Grout-pipes around perimeter at 5' above shoe
1¾" square twisted bars
8, 2" Grout-pipes around perimeter at 3' above shoe
2" Grooves in mortar collar formed by nailing ½ round strips to form. Vertical grooves, every 6 ft around perimeter, connect the horizontal grooves the whole forming a grouting drainage system. Just prior to grouting, air is blown in to clean surfaces.
Oakum
Steel Plate, ¼" thick
A total of 6, 2" pipes around perimeter, two at each groove
3 ft. collar may be reduced to 2 ft. collar depending on rock conditions and ground water level

DETAIL OF SEALING CAISSON TO ROCK

FIG. 5. REINFORCED-CONCRETE CAISSON UNDER COMPRESSED AIR, CITY TUNNEL, CATSKILL AQUEDUCT

The caissons were all sunk through a fine to medium coarse, sharp sand, and the cutting edge generally carried 2 or 3 ft. below the bottom of excavation. So carefully was the work done that no settlement was observed in the vicinity of these shafts that could be ascribed to the caisson work. The dimensions and weights of these caissons, the loading, the frictional resistance, the force employed and the progress made are shown in Table I.

A concrete caisson was not sunk for the shaft itself at Shaft 21, as the contractor took advantage of the option permitted by the contract of inclosing the whole area within the proposed chamber about the shaft by four wall caissons, upon which to carry the superstructure covering the drainage equipment, instead of sinking a caisson for the shaft and in addition a number of small foundation caissons. These four wall, or foundation, caissons were built of plank and timber, about 40 ft. long by 6 ft. wide and about 37 ft. high, with one shaft 3 ft. in

TABLE I. DATA ON CONCRETE CAISSONS OF CITY TUNNEL, CATSKILL AQUEDUCT—SHAFTS 19, 20, 22, 23 AND 24

	Dimensions of Caisson, Ft.					Weight of Caisson in Tons of 2000 Lb.				Depth of Shaft in Caisson, Ft.				Elapsed Working Time in Sinking and Sealing Caisson into Rock, Days				
Shaft	Outside Diameter	Thickness of Wall	Thickness of Concrete Deck	Total Depth Including Portion Remaining in Chamber	Net	With Maximum Load	Frictional Resistance, Lb. per Sq.Ft.*	Maximum Air Pressure Used, Lb. per Sq.In.	As Open Caisson Below Bottom of Chamber	In Earth Under Compressed Air to Highest Point of Rock	In Rock: Maximum	In Rock: Minimum	Total Depth from Bottom of Chamber to Bottom of Caisson in Seal	Sinking and Concreting as Open Caisson	Sinking in Earth to Rock under Compressed Air	Excavating Rock, Dropping and Sealing Caisson	Total from Setting Shoe to Removal of Air	Amount in Inches by Which Caisson Was out of Plumb When Sealed
19	19.3	2.0	3.0	46.1	460	700	300– 400	17	21.7	11.0	14.2	5.0	46.9	34	2	18	54	1.0
20	19.3	2.0	5.5	102.0	1050	2100	630	39	11.2	77.0	14.8	5.9	103.0	51	10	27	88	1.0
22	19.3	2.0	5.0	96.0	978	2470	630– 750	28	33.0	50.3	13.7	2.0	97.0	51	5	23	79	7.4
23	24.0	3.0	6.5	117.6	2323	4612	870–1450	46	19.0	86.4	13.7	3.6	119.1	48	37†	16	101	6.7
24	24.0	3.0	6.0	95.4	1786	4046	945–1685	29	27.5	59.5	10.0	3.7	97.0	54	9	22	85	7.9

* The unit resistance generally decreased with the depth.
† Includes 29 days delay due to repairing of collapsed shafting.

diameter and a lock for both men and muck on each. When in position the caissons above the deck were filled with 1:2:4 concrete to the elevations required by the chamber masonry and by 1:5:10 concrete above, which could be later removed. Sinking was carried on under moderate air pressures, never exceeding 15 lb. per sq.in. When seated, the earth in the pockets below the caissons was excavated to rock, and the decks were cut out and the space below, as well as the shafts, filled solidly with concrete under compressed air; after which, the shafting and the locks were removed, and the half-moon closures between the caissons made. The frictional resistance on these caissons was about 1200 lb. per sq.ft. Altogether, three months were consumed in sinking the caissons and in excavating the space within them preparatory to excavating the shaft in rock.

The cost of sinking these caissons on the basis of the bid prices was $602 to $616 per ft. for the caissons 19.3 ft. in diameter, $838 to $947 per ft. for the caissons 24 ft. in diameter, and $1509 per ft. for the equivalent of the large caisson at Shaft 21 with the additional foundation caissons.

SHAFTS IN ROCK—Aside from the means adopted to take care of water encountered and the placing of a preliminary concrete lining, the sinking of the rock portions of the City Tunnel shafts presented no unusual features, although some novel equipment was employed. A notable advance in the equipment for shaft sinking was made on this work in the adoption of a large hand hammer or "Jap" drill in place of the heavy piston drill mounted on tripod or shaft bar. Two types of hand drills were used, the self-rotating hammer drill of the Ingersoll-Rand Co., weighing about 90 lb., and the somewhat smaller drill of the Sullivan Co., weighing a little over 60 lb. The hand drill has many advantages over the large piston drill, besides those of cheapness and of economy of air and steel. It can be handled more easily in the shaft, can be set up and moved more readily and takes up less room, so that mucking may be carried on with the drilling. Furthermore, the hand drill may be operated by one drill runner without a helper. Some troubles with the drill steel developed in the use of these hand drills, and in the shafts, in the harder gneisses and granites, large piston drills mounted on tripods gave better results. Several types of electric drills were used on one section of the tunnel during shaft sinking, but were given up for pneumatic drills when the tunnel excavation began. Temporary steam plants were used at many shafts for the excavation of the first 100 ft., but electrical equipment was subsequently used as provided by the contracts. The final equipment at a typical shaft using the hand-hammer drills consisted of:

1 Ingersoll-Rand 18¼x11¼x26-in. compressor, capacity 900 cu.ft. of air per min., with G. E. 164-hp. synchronous motor, 6600 volts.
1 Ingersoll-Rand 21¼x12¼x18-in. compressor, capacity 1300 cu.ft. per min., with G. E. 215-hp. synchronous motor, 6600 volts (two compressors installed for tunnel driving).
1 Exeter Machine Works 112-hp. hoist, 230 volts D.C. hoist.
1 Lidgerwood double-drum steam 20-hp. hoist.
1 Root No. 2 blower, 20-hp. G. E. motor, 440 volts D. C., capacity 1500 cu.ft. of air per min.
1 Cameron vertical sinking pump, 12x5x13 in., 3-in. discharge, 4-in. suction, capacity 100 gal. per min.
4 Ingersoll-Rand rotating Jap or hand-hammer drills.
3 Sullivan Jap drills.
2 McKiernan Jap drills.
1 Ransome concrete mixer, 1 cu.yd., 25-hp. G. E. motor.

The work of shaft sinking was carried on by the usual methods and routine. Typical diagrams of shaft holes are shown in Fig. 6. Each of the three rounds was loaded and shot separately and the shaft mucked out before the succeeding round was fired. The depth and size of the shafts, the number and length of holes drilled, the average amount of explosives used per yard, the average advance per round, the average monthly progress and the amount of water encountered are shown in Table II. The amount of explosives varied somewhat with the character of the rock, size of shaft, and methods of drilling and loading, ranging from 1.5 to 3.5 lb. of 40% and 60% forcite per cu.yd. The average for all shafts was 2.1 lb.

Three shifts of men were employed in shaft sinking, on one of which drilling was generally done, and on the other two blasting and mucking. Ordinarily one ad-

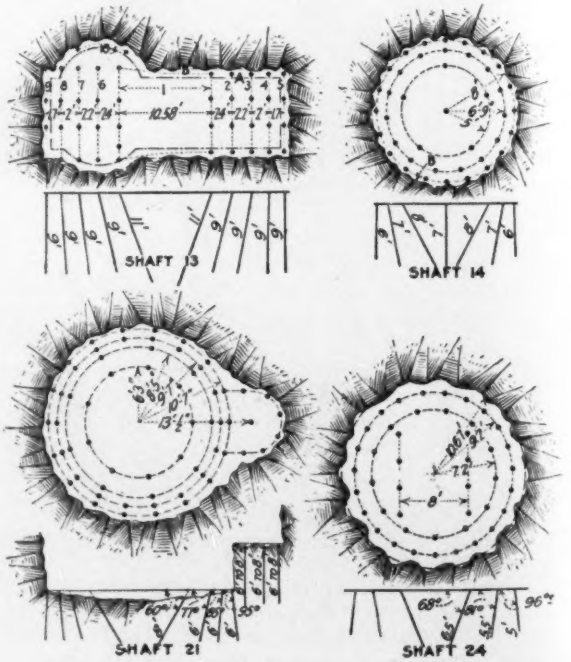


FIG. 6. TYPICAL DIAGRAMS OF SHAFT HOLES

TABLE II. SINKING OF SHAFTS IN ROCK—CONDITIONS, METHODS AND PROGRESS

Contract	Shaft No.	Rock Formation	Depth of Shaft in Rock, Ft.	Ft. of Preliminary Concrete Lining	Nominal Diam. of Excavation in Ft. to Payment Line "B"	Inside Diam. of Outer Lining	Actual Average Volume Excavated per Ft. of Shaft, Cu.Yd.	Average Number of Holes in Round	Length of Holes, Ft. From	Length of Holes, Ft. To	Total in Each Round	Average Advance per Round Ft.	Drills Used	Average Amount Dynamite, Lb. per Cu.Yd. Excavated	Number Months of Excavation and Lining in Rock	Average Monthly Progress, Ft.	Amount of Water Encountered, Gal. per Min. Maximum	Amount of Water Encountered, Gal. per Min. Average
63	1	Yonkers gneiss	240	202	17′ 2″	14′ 0″	9.1	32	8	10	270	6.0	3¼″ Piston	3.5	7.5	32	39	22
	2	Yonkers gneiss	211	157	17′ 2″ 17′ 6″	14′ 0″	9.7	27	8	10	230	6.0	3¼″ Piston	2.8	7.5	28	60	15
	3	Fordham gneiss	174	127	20′ 8″ 19′ 0″	17′ 6″ 15′ 6″	12.1	34	6	8	240	5.0	3¼″ Piston	2.6	6.0	29	16	12
	4	Fordham gneiss	223	161	17′ 2″ 17′ 6″	14′ 0″	8.9	43	6	8	310	6.0	3¼″ Piston	1.8	5.5	40	120	29
	5	Fordham gneiss	197	155	17′ 2″ 17′ 6″	14′ 0″	9.0	35	6	8	246	5.0	3¼″ Piston	2.5	6.0	33	28	17
65	6	Fordham gneiss	261	217	17′ 2″ 17′ 6″	14′ 0″	9.4	33	5	9	230	4.0	Electric and Jap	3.1	8.5	31	8	2
	7	Fordham gneiss	286	256	17′ 2″ 17′ 6″ 17′ 10″	14′ 0″	8.8	30	6	8	188	4.0	Jap	1.7	11.5	25	25	5
	8	Manhattan schist	460	413	17′ 2″ 17′ 6″ 17′ 10″	14′ 0″	8.8	35	7	8	263	4.8	Electric and Jap	2.0	11.5	40	10	2
	9	Manhattan schist	425	405	17′ 2″ 17′ 6″ 17′ 10″	14′ 0″	9.9	28	10 6	12 8	322	6.7 3.4	Electric	1.5	12.5	34	10	3
	10	Manhattan schist	385	335	17′ 2″ 17′ 6″ 17′ 10″	14′ 0″	8.8	34	6	7.5	242	5.1	Electric and Jap	1.6	6.5	60	10	4
	11	Manhattan schist	434	374	19′ 2″ 19′ 6″	14′ 0″	10.5	33	4	6	167	4.1	Electric	1.7	10.0	43	7	3
	12	Manhattan schist	246	227	17′ 2″ 17′ 6″	14′ 0″	9.8	27	6	8	105	3.9	Jap	2.0	7.7	32	3	2
66	13	Manhattan schist	236	Timbered roughly rectangular		.....	15.1	43	9	11	405	7.0	3¼″ Piston	1.5	5.9	39	147	23
	14	Manhattan schist	219	189	17′ 2″ 17′ 6″	14′ 0″	8.7	41	6	8	272	5.0	3¼″ Piston	3.0	2.7	81	0	0
	15	Manhattan schist	196	184	17′ 2″ 17′ 6″	14′ 0″	8.8	34	6	8	218	5.0	3¼″ Piston	3.4	2.8	70	10	4
	16	Manhattan schist	204	194	17′ 2″ 17′ 6″	14′ 0″	8.3	30	6.5	8	198	5.0	3¼″ Piston	2.0	2.5	82	0	0
	17	Manhattan schist	193	155	17′ 2″ 17′ 6″	14′ 0″	8.4	33	8	..	264	6.0	3¼″ Piston	2.0	3.3	53	5	3
	18	Manhattan schist	166	Timbered roughly rectangular		.....	15.5	46	8	10	388	6.5	3¼″ Piston	1.6	3.6	43	21	17
67	19	Manhattan schist	649	610	17′ 2″ 17′ 6″ 17′ 10″	14′ 0″	8.9	42	6	7.5	281	5.2	Jap	2.2	7.9	81	1	1
	20	Fordham gneiss and Inwood limestone	633	583	17′ 2″ 17′ 6″ 17′ 10″ 18′ 2″	14′ 0″	8.8	41	4.5	8	289	6.0	Jap	2.0	7.8	79	40	5
	21	Fordham gneiss (Granodiorite)	714	713	Approximately egg-shaped	.....	17.9	61	6	8	371	4.4	3¼″ Piston	1.8	14.5	49	150	23
	22	Granodiorite	604	568	17′ 2″ 17′ 6″ 17′ 10″	14′ 0″	8.7	34	6	7.6	220	4.6	3¼″ Piston	2.8	8.5	69	240	6
	23	Granodiorite	176	142	21′ 6″ 21′ 2″ 20′ 2″ 19′ 10″	18′ 4″ 18′ 0″ 16′ 0″	12.3	43	5.5	8	260	4.0	3¼″ Piston	2.2	2.3	71	8	4
	24	Granodiorite	208	204	21′ 6″ 21′ 2″ 20′ 2″ 19′ 10″	18′ 4″ 18′ 0″ 16′ 0″	11.8	41	5	7.6	235	4.9	3¼″ Piston	1.7	4.9	39	240	70
Total Average			7740	6571										2.1	167.4	47		

vance was made each day. A force of 50 to 80 men was employed daily at each shaft, as indicated in Table III.

TABLE III. TYPICAL SHAFT-SINKING ORGANIZATIONS EMPLOYED ON THREE SHIFTS DURING 24 HOURS

Classification of force employed daily at shaft, exclusive of teamsters removing muck, and carpenters, riggers and other members of floating gangs	Number of Men of This Grade at Shafts					
	4	13	14	19	21	24
General						
Superintendents	2	2	2	2	2	2
Timekeepers	1	1	1	1	1	2
Storekeepers	...	2	...	2	2	2
Watchmen, magazine keepers	2	3	2	4	5	5
Top of Shaft						
Foremen	...	...	...	2	2	1
Compressor engineemen	1	2	1	3	3	3
Firemen	3	...	...	...	...	...
Blacksmiths	1	2	1	3	2	2
Blacksmith helpers	1	2	1	3	2	2
Hoist runners	3	3	3	3	3	3
Electricians	...	2	...	3	3	3
Signalmen	...	3	...	3	3	3
Topmen	3	...	3	4	9	6
Pipemen	...	...	...	6	4	4
Laborers	...	4	3	1	3	7
Mechanics	...	2	...	...	...	2
Bottom of Shaft						
Shift bosses	3	3	3	3	3	3
Drill runners	6	6	5	9	16	10
Drill runner helpers	6	6	5	...	15	7
Nippers	...	...	2	...	1	1
Muckers	16	18	18	19	36	15
Signalmen	...	...	...	...	3	...
Total	48	61	50	71	118	83

Shafts 4, 14 and 19 are finished 14 ft. in diameter with 8.8 cu.yd. of excavation per ft.; Shaft 24, 16 ft. in diameter, with 11.8 cu.yd. of excavation per ft.; Shaft 13, roughly rectangular and timbered, 15.1 cu.yd. per ft., and Shaft 21, approximately egg-shaped and concrete lined, 17.9 cu.yd. per ft.

The progress in sinking typical shafts is shown graphically in Fig. 7, which indicates clearly the intervals when sinking was interrupted to grout off water or place the outer concrete lining. From 25 to 30 ft. of shaft were frequently excavated each week, and an advance of 37 ft. in compact schist during six working days was recorded at Shaft 10, but the average progress was considerably under these rates, as shown in Table II. The best month's record for sinking and lining was that made at Shafts 14 and 20, where an advance of 112 ft. was made; the average monthly progress for all shafts was, however, but 47 ft., running from 25 to 82 ft. The comparatively slow progress in sinking the City Tunnel shafts was due, to some extent, to the wet and seamy character of the rock and the conditions under which the work had to be done in the midst of the city, but in a large measure to the delay and the disorganization of the sinking force resulting from the interruptions for concreting the outer lining. The actual time consumed in concreting was, however, small, seldom taking, for example, over 16 or 17 days to set up, fill and remove the forms in a 100-ft. stretch of the 14-ft. shafts. The operation was often done in less than half that time. Where the rock required support, little time was really lost in concreting, because the concrete could be placed in but little more time than the timber support and the concrete lining was in every respect better than timber, inasmuch as it made the shaft absolutely safe from falling rock, diminished the fire hazard and cut off the inflow of water. The adoption of the circular concrete shafts represented a notable advance over the timbered rectangular shafts commonly used in the past in this country, and previously employed in the construction shafts of the other pressure tunnels of the Catskill Aqueduct, and is in line with the best mining practice.

It should be noted that it was not in driving the tunnels, but in sinking the shafts of the Catskill Aqueduct, that the greatest success was met in grouting off the inflows of water, and that even in the shafts, grouting was not always entirely successful where done in advance of excavation under unfavorable conditions. It is true that grouting has been extensively carried on in the tunnels, but it has been done almost without exception after the concrete lining was in place. It is difficult and expensive to successfully grout a tunnel heading as it is excavated, and with the prospect of considerable delay and the uncertainty of success, such work is generally inadvisable because ample room can usually be found in the tunnel for pumps with which to take care of the water as it comes. The amount of water which can thus be handled in the tunnel depends altogether on such conditions as the size of the tunnel, availability of plant, necessary speed of driving, etc. In the shafts, however, where space for pumps is so restricted and water seriously interferes with effective work, the water must be excluded by grouting, and nowhere on the Catskill Aqueduct has this work been more effectively done than in the City Tunnel.

One of the most notable examples of successful grouting was in Shaft 4, at the south end of Jerome Park Reservoir, where, at a depth of 180 ft., a flow of water amounting to 120 gal. per min., under a pressure of 70 lb. per sq.in., appeared in drill holes which had penetrated a crushed zone about 5 ft. below the bottom of the excavation, and which was subsequently found to be fully 10 ft. in width, filled with broken and decayed rock. The same crushed

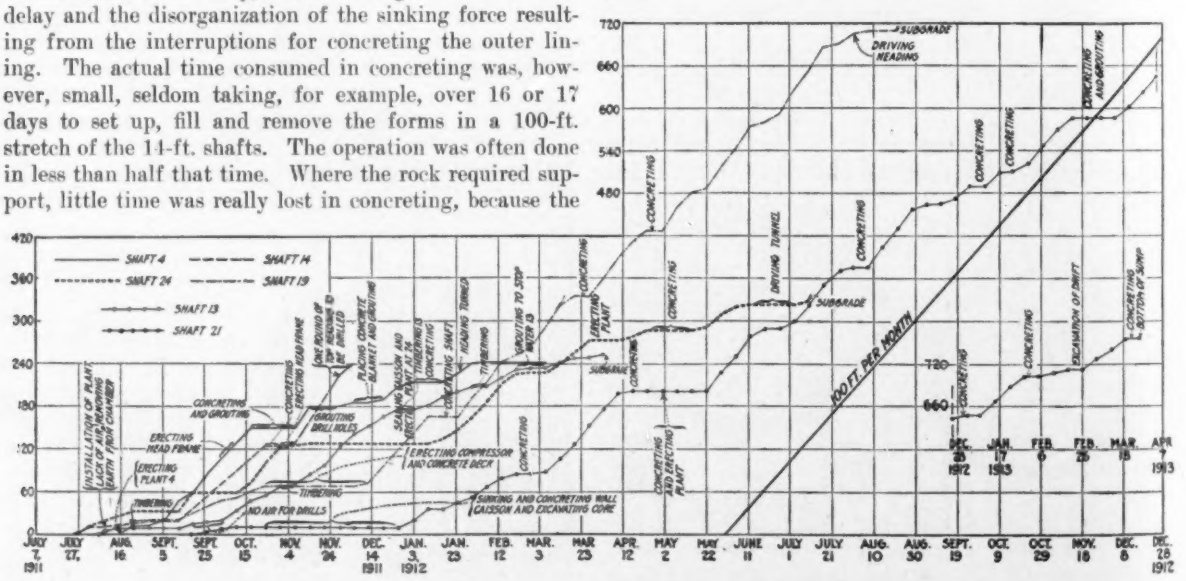


FIG. 7. WEEKLY PROGRESS OF SINKING TYPICAL SHAFTS
(Shafts 4, 13, 14, 19, 21 and 24)

zone was apparently encountered later in the tunnel and yielded nearly 400 gal. per min. Holes of sufficient length to reach the water-bearing seam were then drilled and grouted within an annular space about 5 ft. in width about the periphery of the shaft. These holes were given an inclination outward to strike the crushed zone at or beyond the rim of the shaft, with a view to grouting a cutoff around the shaft through which the excavation could be made. During a period of 18 days, 11 holes 14 ft. in depth, 62 holes 16 ft. in depth and 4 holes 18 ft. in depth were drilled and filled with grout. In order to get nearer to the water-bearing seams and make sure that the holes passed entirely through them, a 5-ft. sump was next excavated down to the upper portion of the crushed zone, which exposed several well grouted seams. Additional holes 16 ft. in depth, to the number of 38, were drilled and grouted from this level. Much of the grout forced into these holes escaped, however, and a concrete blanket reinforced with rails, placed in the bottom, failed to hold it. Pilot holes showed that some water still entered the crushed zone within the limits of the shaft, but as there appeared to be little hope of completely cutting off this water by further grouting, sinking was resumed. When the shaft was excavated through the crushed zone there was a leakage of about 100 gal. per min., which came largely from a seam of sand and mud representing crushed and disintegrated rock, from 2 to 5 ft. in thickness, into which the grout could not readily penetrate. The blowing out of the holes before grouting apparently opened up enough channels through this material to permit considerable displacement, since large masses of solid grout were found in the mud seam when excavated. The seams in the broken rock above and below the mud seam were almost without exception effectively filled.

Altogether, 115 long holes were drilled, and 934 bags of cement, representing about 60 cu.yd. of neat cement grout containing somewhat more than an equal volume of water, were forced into the rock under pressures which, in general, did not exceed 100 lb. per sq.in., though pressures up to 240 lb. per sq.in. were applied. As soon as the shaft had been carried into sound rock about 10 ft. below the crushed zone, the disintegrated and broken rock was trimmed out, the deeper seams dry-packed, sheet-iron drip pans and grout pipes placed to carry away the water, and a reinforced-concrete lining having a minimum thickness of 24-in. put in. When this was finally grouted, the total inflow in the shaft was reduced to 5 gal. per min. The great advantage of the concrete lining in excluding water is evident, and this work well illustrates the statement before made that grouting in advance of excavation is not always completely successful.

No less interesting was the grouting at Shaft 21 at the foot of Clinton St., East River, which was carried to a depth of 740 ft. below sea level. At this shaft the conditions for grouting were excellent, as the granodiorite was sound and hard and the seams clean. Next, cement grout mixed in the proportions of 1 bag of cement to 9 to 12 gal. of water was used. The most serious problem was presented as the rock shaft was started. The surface rock was seamy and carried a good deal of water under the wall caissons. After the shaft was sunk 25 ft. in the rock, a preliminary outer lining was placed and the entire space within the four wall caissons covered with a blanket of concrete 3 ft. in thickness. The grout pipes left in the lining and blanket were then grouted effectively, cutting off most of the water, including the leakage under the caissons. Throughout the excavation of the rock shaft, grouting in advance of the sinking was repeatedly resorted to for the purpose of shutting off small inflows of water that would otherwise have severely interfered with the work. The total leakage in the shaft when completely excavated and lined was only 12 gal. per min.

A further example of this work was at Shaft 24 in Fort Greene Park, Brooklyn, which, like that at Shaft 21, was sunk in the hard granodiorite. Work was suspended at this shaft for four weeks in consequence of unexpectedly striking a water-bearing seam at a depth of 230 ft. below sea level, which yielded 240 gal. per min. through a single drill hole and flooded the shaft. This seam was finally grouted off after 15 holes had been placed in the bottom of the shaft and 54 cu.yd. of grout forced in under pressures ranging from 270 to 375 lb. per sq.in. This was neat-cement grout with 14 to 96 gal. of water to a bag of cement. Below this seam, additional water-bearing seams were encountered for 75 ft. before sound, dry rock was found. The concrete lining was placed in short sections and grouted to cut off the small amount of water that was not excluded by the grouting done in advance of the excavation.

On the basis of bid prices, the cost of sinking and lining the rock shafts of the City Tunnel ranged from $360 to $490 per ft. A large proportion of these amounts probably represented plant charges on shaft and tunnel excavation.

Burned-Clay Ballast

Burned-clay ballast has been used very extensively on railways in the Middle West and Southwest and is still employed. On some lines, however, its use is declining, due to its increasing cost and its unsuitability for track carrying heavy traffic.

The Chicago, Burlington & Quincy R.R. has been using burned-clay ballast on part of its lines in western Missouri and western Iowa, where no other material is available. About five or six years ago it contracted for the burning of two pits of about 500,000 cu.yd. each, but it is not probable that it will use any more. It is very difficult to find suitable material in the vicinity, and the burning is objectionable to residents, while the cost is also prohibitive in some cases, depending on the distance coal has to be hauled. Slack coal, which formerly was given away by the mines, now costs 70 to 90c. per ton.

In regard to efficiency, on this road burned-clay ballast is rated between cinders and gravel, but is considered too light for heavy traffic. It drains the roadbed very well, and is easily worked. Cinders are almost as good and very much cheaper. Any quality of clay without sand or loam is suitable, but gumbo from low land burns to the best advantage. It should be burned, if possible, in the vicinity of where it is to be used, and probably the maximum economical length of haul would be about 100 miles. The depth of ballast varies from 6 to 12 in., according to the quantity available and the character of the railway. No contracts have been made for over 500,000 yd. for one pit; but on other roads, in Texas and other parts of the country, it is burned in larger quantities. It re-

quires two or three months to burn the ballast thoroughly, and almost as long for it to cool.

The raw clay is handled by especially designed excavators used by the ballast contractors. The clay is excavated and conveyed to the burning place, and coal is taken from cars on an adjacent track and spread over the face of the pile, there being alternating layers of clay and coal. The burned clay is loaded onto cars with a steam shovel. It comes from the pit in suitable size for putting under track. Sometimes it is very fine, and when too coarse it is easily broken. It is rarely, if ever, screened. The burning is done almost entirely by contractors, who have special equipment for preparing the material.

The St. Louis Southwestern Ry. uses the material extensively on its Texas lines, the clay being burned by contract. The method employed (in use for over 20 years) is to lay a track, dig a ditch some 8 ft. deep and start in that a fire with old ties or old timbers, putting a layer of coal on top of this. Then the clay is placed over this by means of a dragline machine. On this again is placed a layer of coal, and then another layer of clay, and so on up to a height of five or six feet above the ground. A large rake is then employed to mix the coal and earth together, and the clay pile is allowed to burn until the fire goes out, which is generally six or seven months. The resulting material resembles broken brick, but is harder than ordinary brick. It is loaded with a steam shovel and distributed in the same manner as any other ballast.

The Alaskan Railroad Surveys

By D. L. Reaburn*

The commission of engineers appointed by President Wilson to survey and report on possible routes for Alaskan railways has returned to Washington and will in a short time submit its plans and estimates.

Four coast points, Cordova, Valdez, Seward and Portage Bay, have been considered as possible termini. Cordova, situated on the east shore of Prince William Sound, has a population of about 1100. It is the terminus of the Copper River & Northwestern R.R., which could be extended from Chitina, 132 miles distant from Cordova, up the Copper River Valley and through the Alaskan Range to the Tanana and Fairbanks, a total distance of about 445 miles.

Valdez, from which now runs the government wagon road to Fairbanks, is situated on the north shore of Prince William Sound and has a population of about 1500. The total distance from Valdez to Fairbanks over this route is about 380 miles.

Seward, situated on Resurrection Bay, has a population of about 600. It is the terminus of the Alaska Northern R.R., which extends northerly across the Kenai Mountains for a distance of 72 miles to the eastern end of Turnagain Arm, and which could be extended around Turnagain and Knik Arms to the Susitna Valley and thence up to Broad Pass in the Alaskan Range and down the Nenana to the Tanana and Fairbanks, a total distance of about 460 miles.

Portage Bay is situated on the west coast of Prince William Sound, where no settlement now exists. It can be connected by a 15-mile line, in which there are about 3 miles of tunnel, with Turnagain Arm, and thence northerly through the Susitna and Nenana Valleys to the Tanana and Fairbanks, a total distance of about 410 miles.

In addition to the main trunk lines, branch lines to the Matanuska and Bering River coal fields are being considered. During the past summer the commission, with a large force of engineers, has been engaged on the survey and examination of these routes.

Rapid Organization—The bill authorizing the expenditure of $35,000,000 for railroad construction in Alaska became a law on Mar. 12, 1914. Although the commission of engineers, consisting of W. C. Edes, Chairman, Lieut. Frederick Mears and Thos. Riggs, Jr., was not appointed until May 1, by June 1 the organization had been completed and outfitted with pack horses, boats, equipment, supplies, etc., and on June 6 the last parties sailed from Seattle for the field.

It was realized, on account of the very short Alaskan summer season, that an exceedingly large amount of work must be accomplished in a comparatively brief space of time and that in order to accomplish this successfully the plans must be carefully laid, the proper equipment be obtained and each member of the organization be selected with care, not only with reference to his special fitness, but to his physical condition as well, every man being required to stand a physical examination.

The organization consisted of the headquarters camp and 14 field parties. The headquarters camp was established at the mouth of Ship Creek, at Knik harbor, in which were located one member of the commission, bridge engineer, chief draftsman, disbursing officer, chief clerk and the necessary clerical force, physician, storekeeper, chief packmaster, etc.

Field Parties—The field parties were in charge of the following men: J. L. McPherson, Reconnaissance Engineer; Henry Deyo, R. J. Weir, C. R. Breck, K. K Kuney, W. F. Milliken, D. L. Reaburn, T. H. Bacon, F. H. Bailey, R. A. Gray, Locating Engineers; Eugene Underwood, F. D. Hayden, T. B. Nolan, Jr., Assistant Engineers, and W. C. Guerin, Topographic Engineer.

Each location party was composed of from 18 to 26 men and from 18 to 36 head of pack horses. In addition to the usual organization of locating engineer, assistant engineer, topographer, transitman, draftsman, levelman, chainmen, axmen, packers and cooks, several trained plane-table men, with experience on the government topographic surveys, were attached to the parties for the purpose of sketching the topography adjacent to the line of survey.

Although some of the parties had to travel several hundred miles inland by pack train to reach the point of beginning assigned to them, and did not begin actual survey work until well into the month of July, the entire program as outlined in Seattle before starting for the field was carried through successfully. Each party covered from 60 to 150 miles of line, notwithstanding the facts that it was an unusually wet season in the interior, there being scarcely a day from July 15 to Sept. 15 when no rain fell, and that the parties north of the Alaskan Range had to leave the field before the end of September.

In general, the transportation of supplies was by means of boats on the rivers, supplemented by the pack trains.

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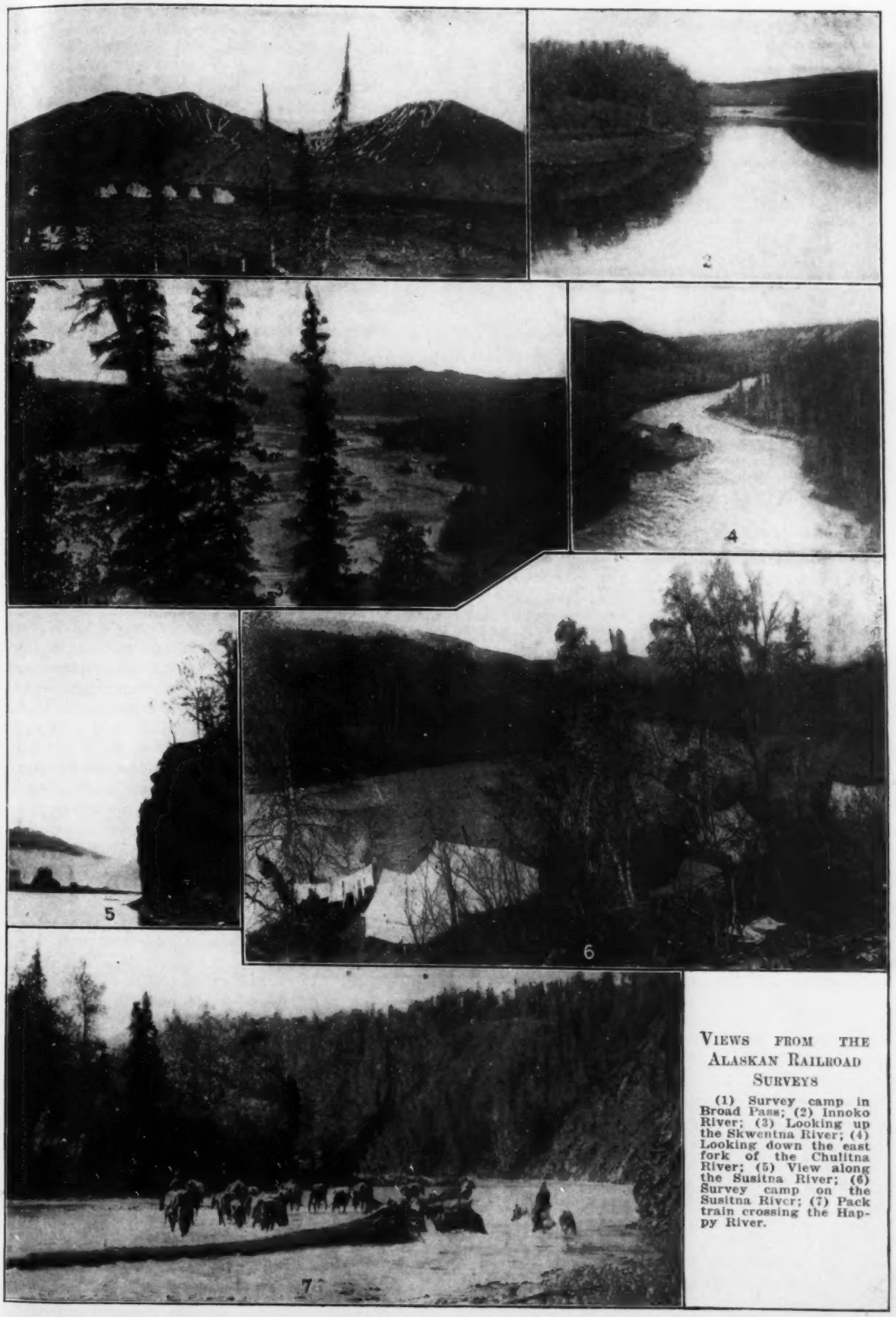

VIEWS FROM THE ALASKAN RAILROAD SURVEYS

(1) Survey camp in Broad Pass; (2) Innoko River; (3) Looking up the Skwentna River; (4) Looking down the east fork of the Chulitna River; (5) View along the Susitna River; (6) Survey camp on the Susitna River; (7) Pack train crossing the Happy River.

The maximum distance from a river base to the camps was about 50 miles, requiring from one to two weeks' time for the pack train to make the round trip.

PERSONAL REMINISCENCES—I had been a member of several government exploratory expeditions in Alaska in the years following the gold excitement of 1898 and 1899. One of these expeditions found us on one occasion destitute of provisions and deep in unexplored territory. It saw us robbed of most of our equipment and clothing by a forest fire, 500 miles inland from our destination on the Arctic coast; it saw us struggling over hard portages with heavy packs upon our backs and later battling in our light cedar canoes against the roughness of the Arctic ocean.

Another expedition, with pack train, saw us fording swollen glacial streams and picking our way across unnamed glaciers never before seen by a white man; it saw us in a wilderness of swamps, into which natives of the region assured us no man could go far and ever return, in which we were plunged into mire as deep as our despondency. It required the united strength of the entire party to extricate the pack horses, while the mosquitoes made life almost an insufferable burden; but looking backward from the vantage of years, time places a golden halo about these experiences.

With the Arctic fever still in my blood, it was with a keen thrill of delight that I found myself on June 13 at Cordova bound for Broad Pass in the Alaskan Range. Our outfit consisted of 21 men, 36 head of horses and about 5 tons of equipment and supplies. The tent equipment was one 10x12-ft. cook tent, one 12x14-ft. dining tent, each of 10-oz. canvas, six 8x8-ft. and three 9x9-ft. mosquito-proof silk sleeping tents, each weighing about 12 lb., and one 9x9-ft. silk office tent.

The office equipment was a drafting board, 36x72 in., split lengthwise for convenience in packing, and two boxes of stationery of suitable size for side packs. The table was erected for use on four stakes driven into the ground and securely braced. The personal outfit of each man was a sleeping bag, a war bag and clothing to about 50 lb. weight in all.

We left the railroad at Chitina, where the outfit was worked into shape for the march. Then we traveled over the government wagon road to Meyer's roadhouse, near the summit of the Alaskan Range, and then turned westward along the base of the mountains to Broad Pass.

The entire distance of 240 miles from Chitina to Broad Pass was covered in 23 days. Each member of the party, except the packers, walked throughout the journey, and the pack horses, after leaving the wagon road, subsisted on the country.

The grass at this early date was yet short and they arrived at the destination in a very weak condition; three of the 36 head were lost *en route*. As we neared Broad Pass, we entered a land teeming with game. Several caribou were killed and everywhere there was evidence of bear and other large game.

On the day following our arrival, which we had taken for a holiday to rest a bit and reconnoiter, the fog lifted, and on the southwestern horizon was revealed the great white dome of Mt. McKinley, America's highest mountain, which, 20,300 ft. in height, towers majestically in snow-clad splendor above its fellows of the Alaskan Range. Despite the fact that it was 60 miles away, it was a most inspiring sight.

We immediately began taking observations on the mountain to determine an approximate elevation for use in starting surveys. The distance from our camp to Mt. McKinley was determined by scaling on a polyconic projection from the plotted position of the mountain along the line of the observed azimuth to the mountain, to its point of intersection with the parallel of latitude of our station, which was determined by solar observations.

The elevation of 20,300 ft. for Mt. McKinley was determined by the writer in 1902, while a member of the United States Geological Survey. It was afterward determined by the United States Coast and Geodetic Survey and by Prof. R. W. Porter, both results agreeing within 10 ft. of the above figure.

As a result of these observations, an elevation of 2400 ft. was used at the initial point of our survey in Broad Pass and carried by wye level southward through the Susitna Valley, closing 24 ft. above the elevations carried up from tide water by the party in charge of W. F. Milliken.

The reconnaissance party in charge of J. L. McPherson, which covered some 500 miles of territory westward from the lower Susitna, Yentna and Skwentna Valleys across the Alaskan Range and through the Kuskokwim and Innoko Basins, traveled through native grass land to which no section of our country can show the equal.

ALASKAN POSSIBILITIES—The agricultural possibilities of Alaska can be realized when one stops to consider that Finland, in the same latitude, with similar climatic conditions and with an area only one-fourth as large as Alaska, supports a population of about 3,000,000.

Finland's industry of second importance is dairying, supplying to a considerable extent the markets of England and Scotland, but it has no mineral resources such as Alaska. It has been estimated that Juneau alone in three years' time will be mining and milling a greater tonnage of ore than is today handled on the Rand, in South Africa.

Alaska with her wonderful resources awaits only transportation, and it is to be hoped that the construction of these lines can be commenced early in the coming spring.

Important Questions on Highway-Bridge Design

BY WILLIS WHITED*

The engineer designing bridges for public use is always more or less at a loss to know what loading to assume for bridge floors. Curbs and railings offer further doubts. A few of the difficulties are outlined in the following article, with suggestions embodying the writer's opinion.

ROADWAY LOADING

UNUSUAL LOADS—Should he assume the heaviest known loads and design with the ordinary unit-stresses? In large cities this is good practice, but even there the engineer is hardly justified in designing *all* the bridges in the city, large and small, to carry the heaviest monuments, castings, steel beams, building members, or stone columns that can be brought into the city. A limit must be fixed somewhere, beyond which the owner of the load is obliged to provide for its transportation by strengthening bridges, adopting different lines of travel, dividing up

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the load, using special trucks or otherwise. It seems extravagant to add a large percentage to the cost of a bridge in order that it may carry a load heavier than is likely to be brought to it once in five years, especially as the necessity for carrying such loads is rarely absolute.

Street Cars—It would seem that all bridges except on boulevards and in parks should be designed to carry street cars, whether they are actually used on that street or not. It is impossible to accurately forecast the growth of a city or to know what traffic is to come on a given street in 25 yr. Street cars are with us and must be provided for, and we can only guess as to the weight they are likely to attain.

It would probably be desirable to build bridges in parks and boulevards no heavier than is necessary to carry the heavy class of automobiles and the road rollers used for paving such roads, thus placing an obstacle in the way of the street railway corporation's grabbing such roads by hook or by crook to the detriment of the traffic they were intended to carry. The same may be said of intercity highways which are only wide enough to carry two lines of traffic.

Bridges in public streets should be built to carry interurban cars weighing 50 tons each. While this is much heavier than ordinary cars, it must be borne in mind that suburban cars are destined to a wide extension, and almost any street in a city is liable at some future time to be called upon to carry them.

Motor Trucks—Roads between large towns are, it seems to the writer, destined eventually to be subjected to the traffic of heavy motor trucks which will carry miscellaneous freight from store, factory and warehouse to residence, or from the small town or the country to the warehouse in the city.

So long as rubber is used for tires, and the present materials for paving, it is hardly to be feared that the gross weight of the truck will greatly exceed 20 tons, with about two-thirds of the weight on the rear axle. In the opinion of the writer, all bridges on important thoroughfares should be designed to carry that load, which will safely cover traction-engine loading.

There are bridges in remote districts which could not without extravagance be built to carry 20-ton trucks; but the road roller and traction engine are a permanent institution. I would recommend for such bridges a *12-ton roller as the lightest design load for any bridge on a public road.* Sometimes there is difficulty in deciding whether a given district will remain remote. I would recommend resolving all cases of doubt in favor of the heavier loads.

Cases often arise in which designing a very large bridge for the heaviest loading would add so much to the cost as to be an unreasonable burden on the taxpayers, while there is another route not requiring such an expensive bridge which would carry exceptionally heavy loads without undue inconvenience to the public. In such cases, notices should be placed warning vehicles carrying loads exceeding a certain amount to take some other route. The driver of a heavy load may feel like taking a chance; nevertheless, there is plenty of law holding him responsible for the resulting accident.

Sidewalk Loading

While roadway loadings are subject to change as above noted, sidewalk loadings cannot change as the years pass, either in character or amount.

Crowds—The weight of a dense crowd of people has in some cases by special exertion been brought as high as 150 lb. per sq.ft. of floor, but such loadings are so rare that it seems to the writer not unreasonable to allow stresses under this intensity of loadings to approach the elastic limit. An ordinary standing crowd will rarely weigh more than 80 lb. per sq.ft., and the only occasion on which crowds even of that density will be gathered will be in cases of some local excitement, such as accidents or similar occurrences in the water or the roadways. In such cases the densest part of a standing crowd can hardly be more than four deep; those in the rear will keep moving, and a crowd with freedom enough to move at all will rarely exceed 40 lb. per sq.ft. An assumed sidewalk load of 100 lb. per sq.ft. on a 4-ft. width, with 50 lb. per sq.ft. on the rest of the sidewalk, is ample for any kind of a bridge, but should be provided for in *all bridges*, whether urban or not, because any district sufficiently populous to require sidewalks at all on the bridge will occasionally produce crowds of considerable density.

Dense crowds of much greater depth occasionally gather to listen to musicians or street speakers, but such things are never allowed on bridges.

Snow—It is hardly possible for crowds to become nearly so dense in cold weather. Since the weight of ice or snow seldom exceeds 13 lb. per sq.ft., it is not necessary to add anything for its weight.

Runaway Vehicles—If the bridge is at the foot of a steep grade it may happen that street cars, escaping from the control of the motorman, will leave the rails and go over on the sidewalk. It may be worth while to allow for such accidents in designing sidewalks, by making the curb high and strong enough to prevent vehicles getting on the sidewalks, i.e., never less than 6 in. high, and often more.

In providing for the case of a car actually mounting the curb and running on the sidewalk, three times the normal stress could be allowed; this might result in badly damaged sidewalks, but would prevent loss of life.

The planks or other details of the sidewalk should be designed to carry not less than 250 lb. concentration, because persons of that weight are not uncommon and a person in walking always places his whole weight on one foot. Plank walks are rapidly going out of use, but they will be with us for many years to come.

In fixing the thickness of a plank, a reasonable allowance must be made for wear and deterioration.

Curb Height

Horse-Drawn Vehicles—Even in the case of a runaway the vehicle must follow the horses. Horses except when under the spell of frenzied fear will never bolt over a fence, and it would, therefore, seem that, where there is no sidewalk, a reasonably high fence on a curb of about 6 in. is all that is required. If there is a sidewalk it is well to make the curb about 16 in. high, which only the lightest wagons could mount. But the sidewalks should be made sufficiently strong to carry the weight of a horse and a light wagon without greatly exceeding the elastic limit.

Automobiles—The ordinary touring car is very often driven at a high rate of speed. Occasionally the driver loses his head or the steering gear gets out of order, in which case the car is liable to mount the sidewalk. The best preventive of this accident would, perhaps, be to

make the curb about 16 in. high and sufficiently substantial to resist the impact of the car.

There are objections to such high curbs: their unsightly appearance and the difficulty of passing from one side of the street to the other. On the other hand, it is hardly practicable to build a fence or even a reinforced-concrete parapet wall sufficiently strong to withstand the impact of a high-power automobile.

A 10-in. curb is sufficiently high to take care of most accidents. But where there is a sharp curve on the approach or the bridge is very wide, so an unruly car would be liable to strike very nearly square, the higher curb is imperative.

As to motor trucks, which travel at a much lower rate of speed, the driver is likely to be aware of accidents to any part of his machine in time to stop before the truck mounts the curb.

Railings

Railings should be made to resist a lateral pressure applied at their tops equal to one-fourth the weight of a row of men leaning against it, or approximately 40 lb. per lin.ft. If the railing is not so constructed that it is impossible for men to climb upon it, it should be strong enough to sustain a vertical load of at least 100 lb. per lin.ft.

If the railings are on a sidewalk, there should be no opening more than 6 in. wide, on account of the danger of children falling, either by walking between the balusters or falling down and rolling underneath.

Bascule Bridge Acting as a Simple Truss Span

SYNOPSIS—The double-leaf bascule bridge of the Canadian Pacific Ry. over the new ship canal at Sault Ste. Marie, Mich., is of the trunnion type and has three special features: 1, it has chord locks which take live-load stresses and convert the two leaves into a simple fixed truss span when the bridge is closed; 2, it is the longest bascule bridge yet built, being 336 ft. c. to c. of trunnions; 3, to provide for expansion and contraction, one of the end towers (with bascule leaf and counterweight) is movable longitudinally, the movement being effected by hydraulic cylinders under control of the bridge operator.

The connection or locking of the leaves of a double-leaf bascule bridge, so that when the bridge is closed it is practically a simple fixed span, is a new development in bascule-bridge design. It is a special feature of the Canadian Pacific Ry. bridge over the new ship-canal approach to the locks at Sault Ste. Marie, Mich., which is the first structure in which this feature is embodied.

Live-Load Lock Connections in the Chords

While the bridge is notable on account of its size and for several features in its design, the main point of interest is in the connection of the meeting ends of the leaves. The most interesting detail is the lock uniting the bottom chords, which transmits the full tension stresses and connects the two halves of the chord into one continuous member. This lock, shown in Fig. 2, consists essentially of a vertically slotted socket on the end of the chord of one leaf and a T-head bar on that of the opposite leaf. As the bridge closes, this bar enters the socket and comes to a bearing against the face of the latter. Vertical flanges or guides bring these interlocking parts into proper position before they engage. Each lock provides for a maximum tension stress of 500 tons.

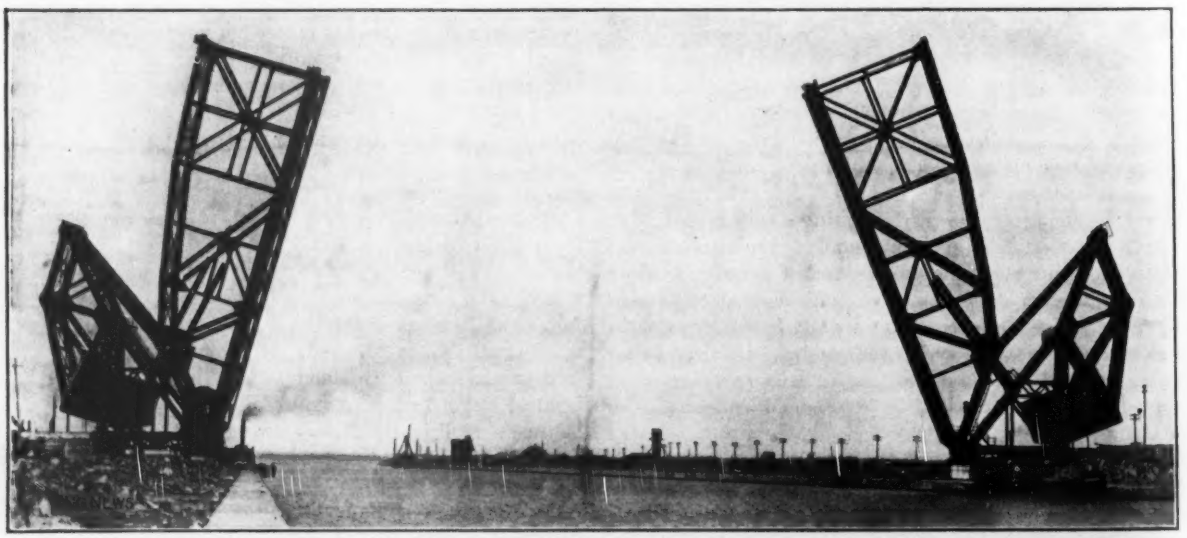


Fig. 1. The Longest Bascule Bridge, 336-Ft. Span; Crossing the New Ship Canal at Sault Ste. Marie, Mich.; Canadian Pacific Ry.

(This bridge is notable in having center locks which convert the two leaves into a simple fixed truss when closed.)

The socket and T-bar are heavy steel castings, with pin connections to the chords to provide for central transmission of the stress. Above the lock are buffers or spacer castings which prevent the leaves from coming so close together as to prevent engagement of the lock.

As the ends of the leaves approach when the bridge is closing, one leaf is kept slightly below the other until

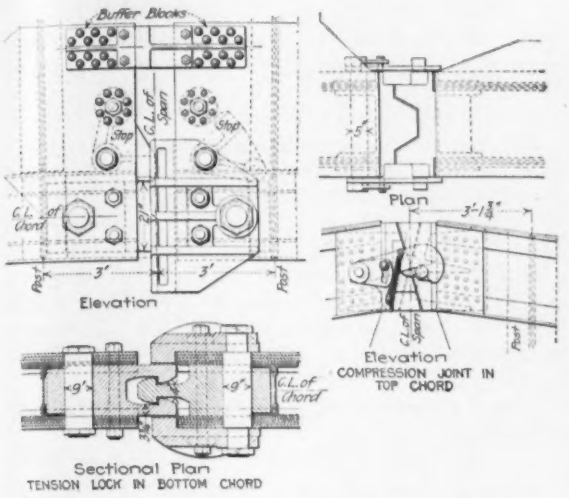


FIG. 2. CHORD LOCKS WHICH CONVERT THE DOUBLE-LEAF BASCULE SPAN INTO A SIMPLE FIXED SPAN WHEN CLOSED

the bottom-chord locks engage, and the operating machinery then pushes both leaves down to their normal position, setting up an initial tension in the lock. The normal arrangement is that the sockets close down over the T-bars, and the leaf carrying the sockets is raised first to break the connection in opening the bridge. Above the socket is a stop casting which bears upon the top of the T-bar so that the leaf carrying the T-bars cannot be raised until the other leaf has been raised high enough to disengage the lock. This is shown in Figs. 2 and 3.

Should it be necessary to reverse this sequence of operations, the stop casting can be swung back out of the way, and a similar casting above the T-bar swung into position. This bears upon the socket casting, so that the leaf carrying the T-bars must be raised first.

The top-chord connection (Fig. 2) is simply a compression joint, each chord having an end casting with finished face. One casting has a tapered tongue fitting a groove in the other casting, so as to hold the chords in line when closed. A hinge is provided in this compression joint to insure proper distribution of stress. For this purpose, there is a horizontal pin in the face of one end casting, which engages a semi-cylindrical recess in that of the opposite casting. This joint is designed for a maximum compression stress of 500 tons and a shear of 160 tons.

The interlocking of the operating mechanism and the signal equipment with the moving part of the drawbridge includes a hooked lever pivoted eccentrically to one of the end castings of the top-chord joint, and engaging a pin in the opposite casting. Until this hook is in proper position the railway and bridge signals cannot be cleared; and until it is released from the pin the operating mechanism cannot be put in service. This is shown in Figs 2 and 4.

GENERAL FEATURES OF THE BRIDGE

While these chord locks constitute the most distinctive feature, the bridge is important in other respects. In the first place, it is the largest bascule bridge yet built,

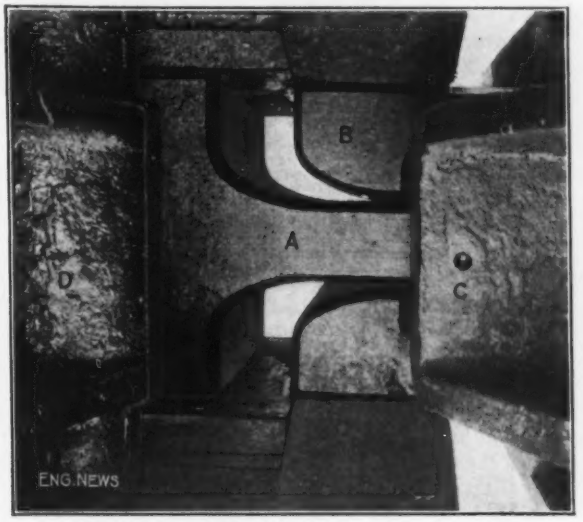


FIG. 3. TOP VIEW OF TENSION LOCK IN BOTTOM CHORD

(A) T-head locking bar on one leaf. (B) Socket casting on opposite leaf. (C) Stop block above socket casting which comes down on the T-head of locking bar. (D) hinged stop block which may be substituted for block C, coming down on the socket casting.

having a span of 336 ft. c. to c. of trunnions. It is a single-track structure, with through trusses spaced 20 ft c. to c. of chords. The floor is of the usual open-deck type, and has three guard rails between the track rails, to conform to the standard practice of the Canadian Pacific Ry. The bridge is designed for Cooper's E-50 loading.

This bridge is of the Strauss trunnion bascule type, with the counterweight for each leaf carried by a pair of counterweight frames which are mounted on a triangular tower and coupled by means of a link to the hip joints of the trusses. The arrangement is such as to give an exact balancing of the span in any position. The counterweights are massive concrete blocks. These drop nearly to the level of the rails and form a barrier when the bridge is open.

The bridge is operated by motor-driven gears mounted

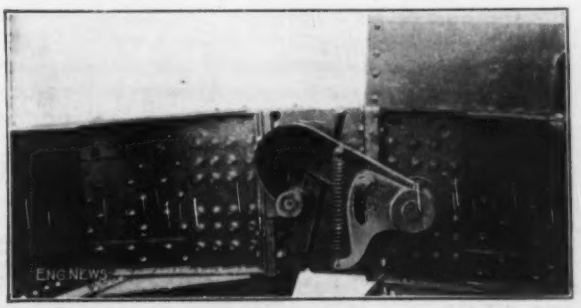


FIG. 4. COMPRESSION JOINT IN TOP CHORD

(The hook is a part of the interlocking mechanism, and has nothing to do with the action of the joint.)

over the portal of each leaf, the main pinions engaging with racks on horizontal operating struts hinged to the end towers. Each leaf has two motors capable of exerting a torque of 300 lb. at 600 r.p.m. and the bridge can be opened or closed in 75 sec. The time from the setting of the "stop" signals on the railway to the complete opening of the bridge is about two minutes. During the navigation season the bridge stands normally open, owing to the small number of trains as compared with vessels.

All operations are controlled from a tower on the south approach, the operator acting under orders from the harbor master.

To provide for expansion and contraction movements, the tower at the south end (carrying the leaf and counterweight frame) is mounted on rollers and has a maximum travel of 4½ in. This movement is effected by the expansion of the bascule span, but under certain circumstances it may be controlled by hydraulic apparatus, consisting of two horizontal cylinders 9x18 in. which are mounted on the pier, and whose piston rods are connected to brackets on the bottom of the tower. The cylinders work with oil at about 200 lb. pressure, the pressure being obtained by a hand pump in the operating house. This pump is locked until current is shut off from the bridge-operating mechanism.

The chord-locks for live-load stresses, as well as the general type of the bridge, are the invention of Joseph B. Strauss, and the bridge was designed by the Strauss Bascule Bridge Co., of Chicago. It was built by the Pennsylvania Steel Co. The design and construction were under the supervision of P. B. Motley, Bridge Engineer of the Canadian Pacific Ry.

Sewage-Works Operation*

One of the first and most important matters to be considered in the operation of a sewage-treatment works is the heterogeneous nature of sewage. Its composition varies widely in different towns, influenced by the ways of living and amount and kind of industrial wastes. Some works receive a sewage so fresh that original fecal matter, paper and fats are practically unchanged, while in others the solids have disintegrated and partly dissolved.

The hourly character and composition of the sewage may also vary from day to day, being uniform in one place and different in another. During storms the sewage collected by a combined system of sewers is increased in volume and its composition changed to a very marked degree.

Many of the forces of nature are utilized in sewage treatment in an involved and complex manner. Gravitation is utilized in sedimentation and in the hydraulics of the flowing liquids; chemical reactions occur in the use of precipitants, in disinfection and in the changing combinations of sewage materials; and biological forces are active in the digestion of sludge and in the oxidation of the dissolved organic matter.

In successful operation, all of these factors must be controlled. It is, therefore, evident that sewage-treatment works, particularly of any size, cannot be made automatic, but require constant observation and supervision by trained, skilled operators in order to accomplish the purpose for which the plant was installed and the funds invested.

The use of biological works for oxidation or the use of disinfection always requires more attention than simple sedimentation. Emscher tanks, which include sedimentation and sludge digestion in a single device, require a higher degree of skill to operate than plain sedimentation tanks. The presence of considerable volumes of trade wastes in sewage usually introduces difficulties not encountered with ordinary domestic sewage.

Constant attendance upon a sewage plant for a private estate or small institution is unnecessary. Such plants should be simply designed, so that an employee with other duties is required to give but a small part of his time to the care of the plant. But in such cases successful results are not always obtained unless the designing engineer or some competent person is called in at regular times to inspect and advise concerning the technical details of operation. Such inspections are particularly important during the early life of the plant to train the attendant to observe and interpret the conditions which required attention.

For the larger institutional plants and works for small towns more skilled attendants are required and the need for competent supervision more urgent.

In municipal sewage-treatment works of any magnitude the constant services of a scientifically trained man in charge is practically essential to success. The larger volumes of sewage treated afford greater potentialities for the creation of nuisance from bad odors if the works are not constantly kept in the best condition. The effect upon the receiving body of water is also greater and a deterioration in the quality of the final effluent may allow the development of conditions, such as nuisance in the water course or danger to water-supplies, which it is the very function of the works to prevent. And finally it is economical to pay a liberal salary to the right kind of man to keep the annual charges for operation and maintenance at a minimum figure by business-like management.

Records—The keeping of careful, thorough and neat records of operation is essential to efficient operation. State authorities charged with supervision over the condition of the water courses should require a uniform record. Such records from the operating point of view show the effect of changing methods of operation and enable the selection of the most efficient and economical procedure. Complaints of citizens can frequently be answered and explained away by reference to the records, and often well kept records have prevented suits or lessened damages.

Records, to be really valuable, should not be cumbered with useless data. The essentials should be carefully determined and made graphic wherever possible.

Neatness—Too much stress cannot be laid upon the importance of neatness and cleanliness in and around the works and the surrounding grounds. To accomplish its purpose this cleanliness must begin in the sewer system, for accumulation of decomposing matters therein will surely hasten decomposition to such a degree that at times no amount of care at the works can prevent the dissemination of bad odors. The cleanliness begun in

*Extracts from a Progress Report of the Committee on Sewage-Works Operation and Analytical Methods to the Sanitary Engineering Section of the American Public Health Association, presented at Jacksonville, Fla., December, 1914. The membership of the committee is: W. L. Stevenson, chairman, 412 City Hall, Philadelphia; C. B. Hoover, Columbus, Ohio; H. C. McRea; Langdon Pearse, Chicago, Ill.; George C. Whipple, New York City. The portion of the report dealing with analytical methods was printed nearly in full in our issue of Jan. 14, 1915.

the sewers should be carried out through the plant and no filth should be allowed to accumulate, but it should be promptly disposed of.

But small expense is involved in laying out flower beds or shrubbery, especially at the entrance, and to serve as a screen around unsightly parts of the works. A moderate amount of attention to these details removes the inherent prejudice in the mind of the visitor or passerby.

A City Street Traffic Investigation; Bridgeport, Conn.

By Alfred F. Muller*

Bridgeport, Conn., is growing steadily in population, and the number of vehicles using the streets is greatly increasing—all out of proportion to the increase in inhabitants—and as a result the problem of street congestion is becoming more and more difficult to solve.

In connection with replanning, the question of the location, size and approaches of a proposed new bridge across the Pequonnock River was brought up. Fig. 1 shows the location of the present condemned Stratford Ave. Bridge, and the immense importance of a bridge at this point, which is the main east and west connection between the two sections of the city.

The western approaches of this bridge lead through the heart of the main business district, while the eastern

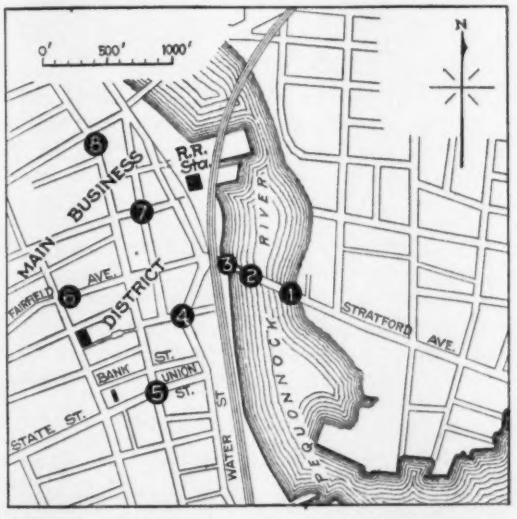


Fig. 1. Plan of Location of Stratford Ave. Bridge, Bridgeport, Conn., Showing Traffic Stations

approaches are the main routes to the thickly settled factory and residential sections. The streets on the west side are narrow, inadequate, and as a result, badly congested.

Traffic Data Wanted—The traffic data wanted were figures and facts showing the volume, origin and destination of all vehicles crossing the present bridge, and the routes traversed in approaching the bridge.

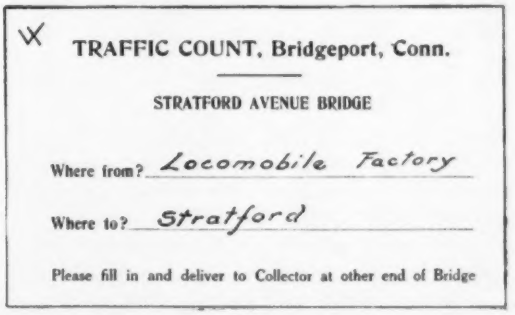
Owing to the congestion of the western approaches and the complexity of the street layout feeding the bridge, the problem of collecting the necessary data on the west side was a difficult one. Several schemes were proposed, but finally rejected in favor of the one described. On the other hand, the simple street network feeding the eastern end of the bridge made the work in this section comparatively easy.

Method Employed in Collecting Data—In order to gather the necessary data, two shifts of eight college men and eight policemen, or thirty-two men in all, were employed. The police were used to simplify the handling of traffic. Each shift was of six hours' duration, 7 a.m. to 1 p.m., and 1 p.m. to 7 p.m. Two consecutive days were chosen on which to make the count, Friday, July 17, a normal day, and Saturday, July 18, a heavy day.

The 16 men in each shift were assigned to the eight stations, marked in Fig. 1, singly or in groups, according to the amount of traffic to be handled. Thus, Stations 2, 3, 4, 5, 6 and 8 were 2-man stations, while Station 1 was a 3-man and 7 a 1-man station.

Stations 4 to 8 were termed "distributing stations." At these points all eastbound traffic was asked the simple question: "Are you going over the Stratford Ave. Bridge?" If the answer was in the affirmative, a ticket shown in Fig. 2 was handed the driver with the request to fill it out. This ticket had the station symbol plainly marked in one corner.

The driver upon receiving his ticket was allowed to proceed unmolested to the bridge, unless he passed a second station, where his ticket was marked to indicate his passing that station. At the entrance to the bridge all traffic was stopped by two checkers, who made sure that


TRAFFIC COUNT, Bridgeport, Conn.

STRATFORD AVENUE BRIDGE

Where from? Locomobile Factory

Where to? Stratford

Please fill in and deliver to Collector at other end of Bridge

Fig. 2. Vehicle Ticket for Traffic Census, Bridgeport, Conn.

all vehicles had slips, and that they were properly filled out. All tickets of eastbound vehicles were collected at the middle of the bridge.

The data relative to westbound traffic were collected in the following manner: Three men were at Station 1, the east entrance to the bridge, whose duty it was to stop all westbound vehicles and ask the questions given on the ticket. The answers were written down by the talliers. It was possible to employ this simple method on this side of the bridge because of the few streets used in approaching the bridge, and hence the data were easily secured. This will be seen by a glance at Fig. 1.

Tabulating—At the end of the two days' count, there were over 7000 tickets. Tables were prepared, and somewhat over a week spent in the tabulation.

The check in the upper left hand corner of the ticket, Fig. 2, indicates the station at which the ticket was issued, Station 5 in this instance. The single line through the

*Staff of John Nolen, Landscape Architect, Cambridge, Mass.

check explains that in moving from Station 5 to the bridge, Station 4 was passed. These two marks, coupled with the tabulations of the tallier at Station 4 as to whether his station was passed via Wall or Water streets, fix the route traversed by the vehicle in the business district on the way to the bridge.

The completed tables showed that the vehicle (ticket Fig. 2) moved from District 2 (location of Locomobile factory) to the suburb of Stratford, and in doing so passed via South Main, Wall and Water streets to the bridge, thence via Stratford Ave. to Stratford.

PLOTTING DIAGRAMS—The tables having been completed, it was necessary to marshal this formidable array of facts into some graphic form quickly and easily digested. Two diagram maps were plotted for each day, one diagram showing volume of traffic using the bridge approaches, and the other showing volume originating and terminating in each city district and suburb. The latter was a small-scale map of the city with circles in the different districts, showing the volumes of traffic by sizes of circles, with arrows to denote direction. Two symbols were used, one for traffic originating in the districts, and one for traffic terminating in the districts. The other diagram was merely a sketch plan of the congested streets, in which the width of the street was proportionate to intensity of traffic—in duplicate, for traffic going each way, so that the diagram looked like two street plans superimposed.

FURTHER TRAFFIC DATA—Further investigations were made to ascertain the number of pedestrians using the bridge, and the number of electric cars passing daily. A prior count had shown the character of the traffic crossing the bridge, whether light or heavy automobiles, trucks or carriages, etc.

Inquiries were made among vehicle drivers to ascertain routes followed, the reasons for following these particular routes, etc. The experience of the traffic police was taken advantage of, fluctuations in the intensity of traffic at different periods of the year noted, and condition of pavements judged. In short, a most exhaustive study was made.

The work was done under the supervision of Dr. John Nolen, city planning expert, of Cambridge, Mass., for whom the writer was assistant.

* *

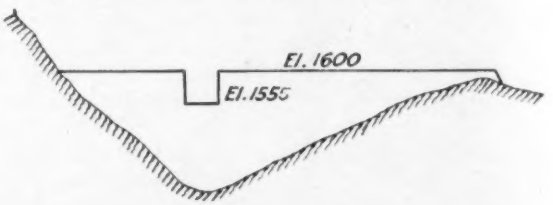
Leakage from Cedar Lake Reservoir, Seattle Water-Supply

BY CHARLES EVAN FOWLER*

SYNOPSIS—The reservoir created by the new Cedar Lake Dam for the water-supply and municipal hydro-electric plant of Seattle is leaking through a pre-glacial subterranean channel under a morainal bank into which one end of the dam abuts. Construction was undertaken in face of repeated adverse reports by different engineers and geologists. Earth is now being sluiced in reservoir in effort to silt up the leaking channel.

The first Cedar Lake Dam was a log-crib structure used to impound water for supplying the City of Seattle, Washington. (ENGINEERING NEWS, June 17, 1909, p. 647.) This dam was also used to supply water for the municipal hydro-electric plant. The construction of a massive concrete dam at a point about one and one-third miles below the former outlet of Cedar Lake has just been completed at a cost of approximately $1,500,000. This dam has a length on the crest of 795 ft., a height of 160 ft. above the old stream bed, 200 ft. above bedrock in midchannel and about 217 ft. above the deepest portion of the foundation. The dam is curved in plan, although it has a gravity section.

It abuts on the rock wall of the mountain at the south end, but at the north end the masonry section terminates in a gravel plateau or morainal bank which lies at right angles to the dam and is in appearance a saddle reaching out to the west from the main mountain to the east of the dam. This morainal bank or ridge is not a true moraine, the bank being morainal material crowded over into the old channel when the new was formed. The topographical condition may be noted in the sketch in Fig. 1 and the view in Fig. 2. As originally designed the water face of this saddle was to be puddled and an earth dike with concrete core wall built from the north abutment of the dam easterly to the 1620-ft. contour of the mountain, providing there a crest 20 ft. higher than the dam proper. As actually built there



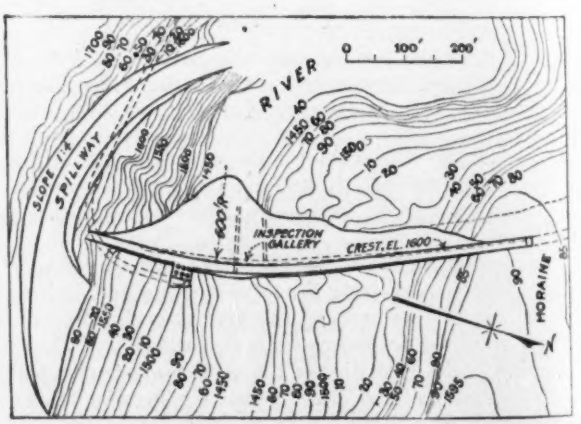


FIG. 1. SKETCH PLAN AND SECTION OF CEDAR LAKE DAM

*Consulting Civil Engineer, Seattle, Wash.

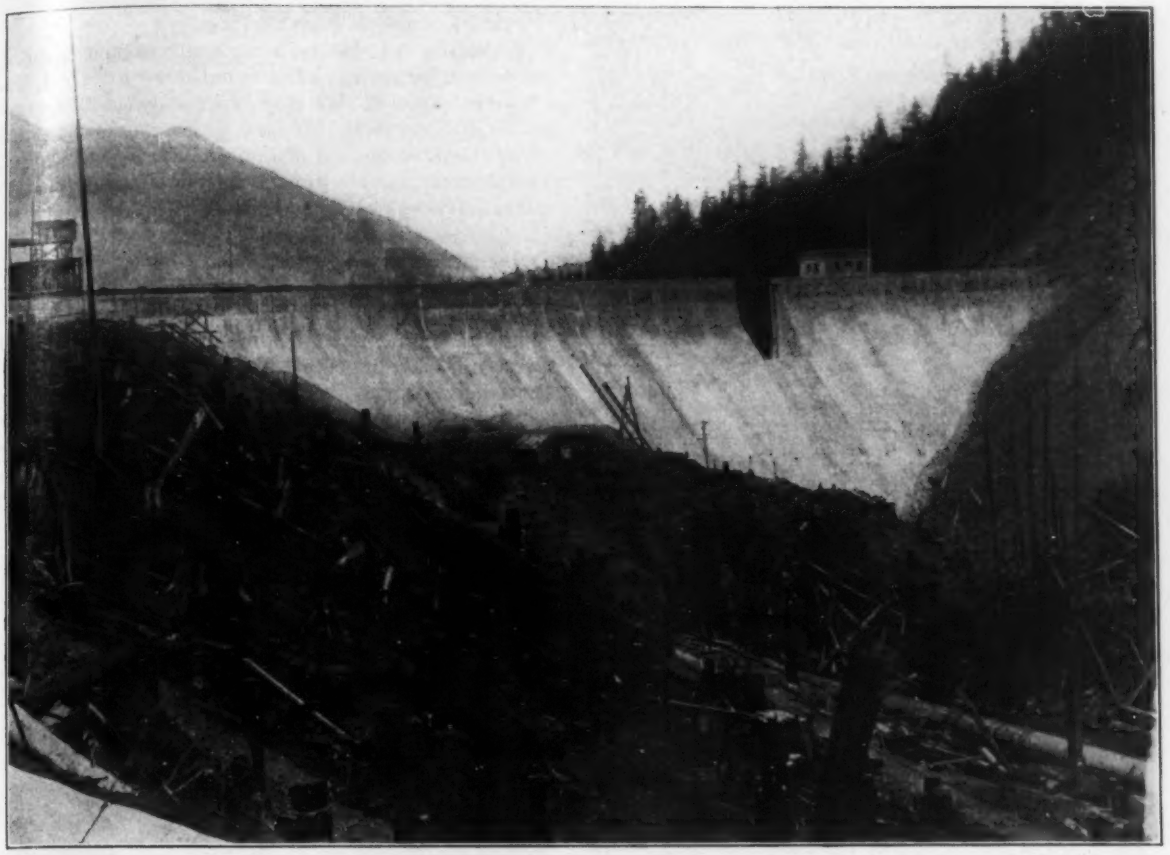


FIG. 2. DOWNSTREAM FACE OF CEDAR LAKE DAM, SEATTLE, WASH.
(Note saddle, a morainal bank, on left; top of saddle about El. 1590, top of dam El. 1600, spillway opening shown El. 1555)

was no north abutment to the dam, but its crest stood some 10 ft. higher than the top of the moraine, as shown in the section in Fig. 1. No cutoff wall was built nor was any puddle applied to the reservoir face.

The reservoir created by this dam has a capacity of 146,500 acre-ft. up to a crest elevation of 1600, to which the dam has been completed.

PREVIOUS INVESTIGATIONS

When the plan was first proposed, a Board of Geologists, consisting of Henry Landes, State Geologist, now president of the University of Washington, and Milnor Roberts, professor of mining engineering at the same institution, made a report in July, 1910, calling attention to the fact that Cedar Lake has a pre-glacial subterranean channel to the Snoqualmie Valley on the north, and to the possibility that under the great head proposed by the new dam, the waters might be forced out this way.

This was, however, disregarded and plans were proceeded with for building the dam as designed, but no definite plan was adopted for rendering the north abutment water-tight, further than to propose in case the use of puddle upon the reservoir face failed to make it tight, that a cutoff wall of some type could be constructed for a distance of 1000 ft. or more through this north bank or terminal moraine of loose rock, sand and gravel. The data in the City Engineer's office, including the test pits shown on Fig. 3 in which water stood, convinced the city's engineers that the dam had been located at the proper site.

Public clamor became so intense against the building of the dam at this location that the City Council, by ordinance on Mar. 5, 1912, caused a Board of Engineers to be appointed to investigate and report on the entire project. This Board consisted of Joseph Jacobs, E. H. Baldwin and Glover F. Perin, and their report dated May 6, 1912, recommended that the whole project be delayed for a sufficient period to enable a thorough investigation to

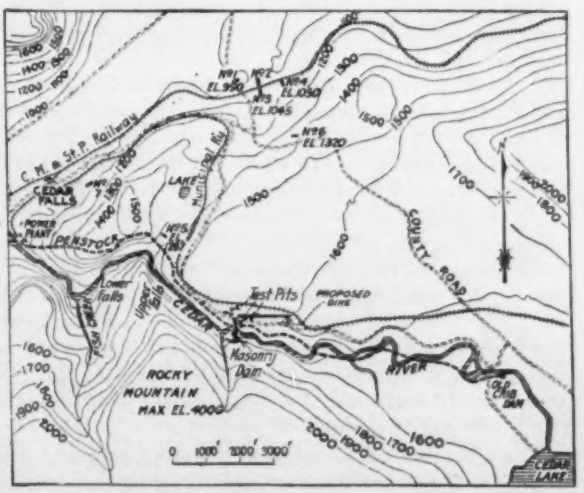


FIG. 3. GENERAL LOCATION OF CEDAR LAKE DAM, SHOWING WEIRS MEASURING LEAKAGE

be made not only at this location, but of a location they suggested for an earth-fill dam at a point about 4800 ft. further upstream and 2000 ft. below the old timber-crib dam.

This report was very exhaustive and among other things called attention to the porous character of the rock on which the dam was to be founded, and also of the same character of rock composing the south wall or abutment. The morainal bank which formed the north abutment and bank was as fully investigated as was possible from the data available, and further borings recommended to determine more closely what the leakage would be and the best means to reduce it. Their deductions from the best data available indicated a probable leakage of from 50,000 to 65,000 acre-ft. per annum, or a 20% loss in storage and power possibility, although it was thought highly probable that the loss would exceed the above figures.

The recommendation was made that the foundation and south abutment be carefully grouted and a cutoff made at the north abutment by excavating a trench down to El. 1550, driving sheetpiling down to El. 1490 and filling up the trench with selected material.

Work at this time had been in progress by day labor in making borings, clearing, stripping and preparing the foundation. This method of conducting the work was proving very expensive, over $600,000 having been expended on foundations, and as the city authorities had decided to ignore the report of the Board of Engineers and proceed with the work without making further examinations, the Chamber of Commerce of Seattle, through its Taxation Committee, instituted a further investigation.

Among reports received by them was one from Joseph Jacobs, a member of the former board, and one from R. H. Ober, Superintendent of Buildings and former Assistant City Engineer in charge of certain features of the dam and reservoir. Mr. Jacobs called attention to the recommendations made by the previous Board of which he was a member and reiterated his belief that a more thorough investigation should be made.

Mr. Ober's report placed the possible leakage at a much larger percentage than that previously quoted and stated his belief that for this reason the new dam would not increase the storage and power possibilities over what then existed with the old log-crib dam, which held a less head of water and had consequently a much less loss from leakage through the porous north bank. Mr. Ober had proposed a plan for tapping the water from the bottom of the old storage lake, by means of a tunnel, constructing a permanent dam near the old log-crib dam, thus increasing the storage capacity up to about the theoretical capacity of the proposed new concrete dam to El. 1555. His belief as to the great loss from leakage was based primarily on the fact that test pits dug before the first reservoir was built developed the fact that when water from the river was turned into certain of these pits, it disappeared into the pervious material very rapidly, in one case disappearing with a roar. With the new dam the head would be increased and with the more porous nature of the formation at the north end of the dam this loss would make the project nearly prohibitive.

The Chamber of Commerce, however, approved the project and the net result of this investigation was to cause the stopping of the work by day labor and a contract to be let for building the dam.

Leakage

While the dam has been practically completed to El. 1600, a center section was left out down to El. 1555, as shown in Figs. 1-2. Water was impounded in the new reservoir in November, 1914, and with a depth at the dam of 80 ft. above the bed of the stream, continued to leak steadily away, largely through the moraine, into the Snoqualmie Valley. *No puddling had been attempted nor cutoff wall built.*

One spring which has increased to a large amount is below the dam (Fig. 4). This flows back into Cedar River and is presumably from leakage through the moraine and not through the seamy rock. The total fall in elevation at the head stated was approximately one inch per hour, and after lowering to a depth of 70 ft., the level is still steadily disappearing at the same rate of about one inch per hour, or over 30,000,000 gal. per day.

Weirs are maintained in the streams on the north slope of the saddle and an endeavor made to locate the leakage by comparison with the readings of former ones before the leakage began. The farthest leak outlet so far found is in the Snoqualmie watershed over one mile north of the dam.

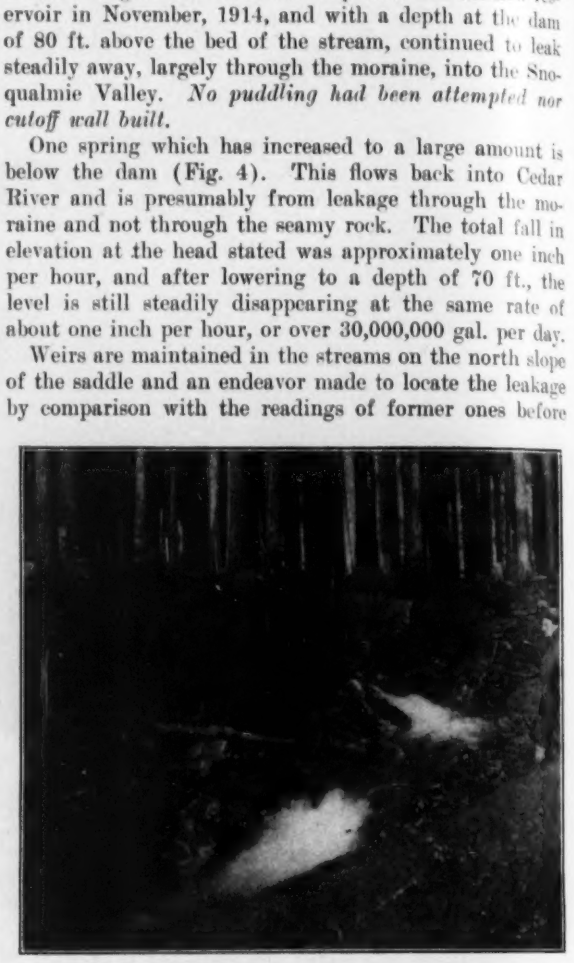


Fig. 4. Spring near Cedar River below Dam, Showing Leakage Flow

The report of the assistant engineer engaged in these observations is as follows:

> Nos. 1, 2, 3 and 4 weirs, which have been read for three years, showed no undue increase until Dec. 10, 1914, when Nos. 1, 2 and 3 showed an increase of 50, 225 and 165%, respectively, two new springs appearing to increase the flow of No. 2.
>
> No. 5 weir was installed Dec. 3, on which date there was a flow of 19.7 cu.ft. per sec. A maximum flow of 26.8 cu.ft. per sec. was reached on Dec. 7, receding gradually. The present flow of this stream is estimated at three or four times its normal volume.
>
> No. 7 stream has weir readings for part of 1911 and all of 1912. Readings taken Dec. 8, 9 and 10 show an increase of 2.9 times the flow of 1911 and 1912 of corresponding dates and 1.2 times the maximum flow of any period. The maximum flow of this stream occurs normally in February.
>
> From Dec. 3 to 15 no precipitation has occurred, the weather remaining cold and dry. Frost is in evidence in many parts of the ground, indicating an increase in the above streams to be not due to local weather conditions.

The leakage in and under the dam itself is practically of no account, and in only one place in the drainage gal-

leries of the great monolith is any water coming through the masonry and this is a very small seepage.

The Snoqualmie watershed is now being thoroughly surveyed and examined to determine whether or not there are other leakages showing up, and to make possible a summary as to the total loss going this way.

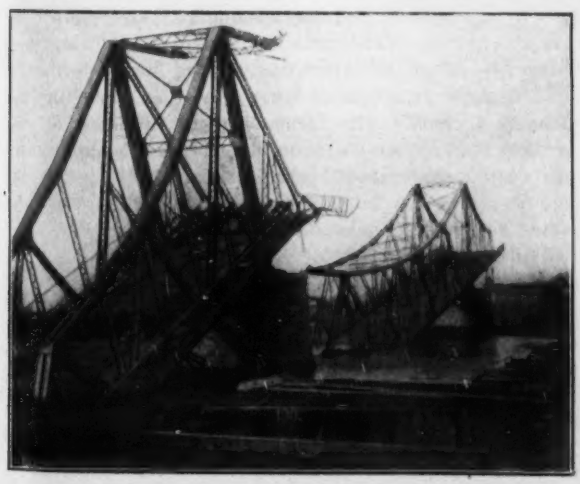
The city does not at present contemplate building a cutoff wall in the moraine, nor have any borings been made to locate the bedrock or old pre-glacial channel of the Cedar River to the Snoqualmie Valley, but a plant is now being installed to sluice material into the reservoir in an attempt to stop the leakage by silting up the entire porous northern wall of the reservoir up to the old crib dam for a probable distance of 6800 ft. In the meantime, however, test pits and borings will be put down in the morainal bank to locate bedrock and the old pre-glacial channel, preparatory to putting in a cutoff wall if the silting up does not stop the leakage. The attempt to close up the porous material by silting will be of small cost and may obviate the cutoff wall, which would cost a comparatively large sum. On Jan. 4, the leakage at that time being considerably greater than was at first anticipated, $15,000 was appropriated to add to the repair plant.

R. H. Thomson, M. Am. Soc. C. E., former City Engineer, and who planned and constructed the first dam and reservoir at Cedar Lake and who planned, located and began the construction of the present system, estimates that it may take from one to five years to make the reservoir tight, either by the silting-up method or by grouting. This latter method would undoubtedly be quicker if it proved effective, but would be very expensive.

The design and construction of the dam have been carried out under A. H. Dimock, the present City Engineer, with T. H. Carver, Assistant City Engineer, in direct charge of the designing.

Bridge Destruction in the European War Zone

In our issue of Nov. 19 we published views of some of the bridges destroyed in the course of the war operations in Europe. Views showing the wreck of some bridges of longer span are shown herewith. Both the cantilever bridge and the truss bridge crossed the Dniester River,



Wreck of a Cantilever Bridge across the Dniester River

A Fallen Truss Span Across the Dniester River

one of the large rivers of Galicia, which empties into the Black Sea near Odessa.

In the view showing the wreck of the cantilever bridge the ends of the pontoons are seen on the right which carry a temporary military bridge thrown across to take the place of the wrecked span. The third view in the series shows a heavy lattice girder across a stream in the valley of the Aisne, on the western battle front. As

A Broken Girder Bridge in the Valley of the Aisne

nearly as can be judged from the photographs, it is probable that the cantilever bridge was wrecked by exploding dynamite charges against the top chords. The fall of the girder bridge was brought about by dynamiting its lower chord and the long truss span across the Dniester was brought down by placing heavy dynamite charges in the channel piers.

The Fuel Value of Wood, according to data given out by the Forest Service of the Department of Agriculture, is about half that of coal of equal weight. In bulk, one cord of dry hard wood is roughly equal to a ton of coal. Of the softer and lighter woods, such as shortleaf pine, hemlock, Douglas fir, about a ton and a half is required to equal a ton of coal, and the lightest woods, such as cedar, poplar, spruce, and white pine, require two cords to equal a ton of coal. In a cord of wood of 128 cu.ft. a fair average of solid wood is about 80 cu.ft.

Engineering Literature

REVIEWS AND NOTES

A Comprehensive German Treatise on Engineering Studies and Works for Water Transportation

REVIEWED BY ALLEN HAZEN*

HANDBUCH DES WASSERBAUES Für Das Studium Und Die Praxis—Von Hubert Engels. In Two Volumes. Leipzig and Berlin: Wilhelm Engelmann. Paper; 8x11 in.; pp. xii+1499; 1623 text illustrations. Paper, 100 Marks. Bound (in calf) 106 Marks.

To one who has observed the use that the Germans make of their rivers in the transportation of heavy products, and who wishes to understand the principles of construction that have been used in this unequaled development, the work of Professor Engels will be most welcome. Life-long and intimate familiarity with working methods has given him first-hand knowledge of the subject in its broader aspects, as well as in its details. And through long experience in teaching he has learned to express clearly, and in simple terms, the essentials of the matters that he presents.

The illustrations are good and complete. They are always clear and each illustrates some point of significance. Nothing that is necessary to convey the desired idea is omitted, and not an unnecessary line or figure is used.

One who has had the pleasure of hearing Professor Engels lecture at the Royal Technical School at Dresden will readily understand how the illustrations have been prepared. The drawings on the blackboard before his classes, in making which he has acquired unusual proficiency, have been redrawn somewhat more carefully than in the free-hand way in which they first appeared, but with little further change and without sacrifice in clearness. They are always drawn from a teacher's point of view, being arranged to convey the needed lesson and to avoid confusing the student with anything not pertaining to the subject matter. Even the drawings that represent constructed works have been redrawn to make them as far as possible uniform with the others and suitable for publication in the text, and to show in the simplest and clearest manner the works that they represent, and how they were built or how they operate. It is really extraordinary that large works can be so well represented by small drawings in the text. In the whole work there is not a single folded diagram or map.

After turning the pages one feels as if he had a real view of the whole shipping industry of Germany presented with such clearness that it cannot be misunderstood.

The work is written both as a textbook and as a handbook. The writings of others are freely used, and references are given, but after all, the works constructed and in use in Germany and neighboring lands with which the author has had to do are the subject matters; and for the most part they are treated on first-hand information and from personal knowledge.

The reviewer remembers Professor Engels telling his class, many years ago, that to improve a German river involved engineering difficulties and an expense equivalent to that of the construction of a double-track railroad on easy grades through a mountainous country. This statement is fully borne out by the impression left by the description of the works that have been built for improving the German rivers.

In addition to matters directly relating to the improvement of rivers and navigation, many allied subjects have been treated, and these justify the broad title, "des Wasserbaues," which is given to the work. Nevertheless, navigation and the matters relating to it are the principal subject matters of the work.

In the first volume the first part treats of the occurrence and movement of water. It begins by a discussion of winds and storms and statistics of precipitation from all over the world, from the standpoint of seasonal and annual fluctuation. The records of Germany and German colonies are given special prominence. Evaporation from water surfaces and from land surfaces is discussed. The influence of ground water upon stream flows is treated. The flow of water in pipes, aqueducts, and especially in river channels and in canals is considered at length and the backwater problem is studied. The discussion of waves and wave action is most complete and runs through many pages.

The second part, on Hydrography, treats of both fresh and salt waters and describes the appliances for measuring and studying the movement of water, including waves and sea currents. The relation between precipitation and runoff is discussed, and the relation of water quantities to gage heights. The methods of plotting the data are frequently novel and interesting. Flood flows are considered, and the influence of lakes and other retarding influences thereon. The formation and influence of ice is taken up. The ocean is considered from the standpoint of its composition, its temperature, its currents, its waves, and its tides. Apparatus for sounding, for recording water heights and velocities, are described.

The third part treats of river improvement in all its branches, extending from the smallest tributary to the mouth of the largest river. The author's well known experimental work in his hydraulic laboratory, with small artificial rivers in sand channels, is reflected, and the principles so ascertained are applied to actual conditions in German rivers. In other words, experimental research is applied to and is made to supplement the knowledge of channel conditions obtained from actual experience. In many respects this is the most important part of the work. The practical directions for controlling and im-

*Of Hazen, Whipple & Fuller, Consulting Engineers, 30 East 42d St., New York City.

proving channels run through many pages and reflect the best current German practice.

The fourth part deals with dams for navigation, for impounding reservoirs and for water power. The treatment is general, but that part relating to the construction of river dams of moderate height on alluvial bottoms, and the protective work necessary to prevent undermining, is treated with relatively greater fullness. The construction of moving dams and of large gates is fully treated. The section on water power reflects, for the most part, practice on German rivers with large water quantities and low and variable heads.

The fifth part treats of the protection of land against water. It includes the protection of lands against rivers and against the sea, dunes and dikes, and the action of waves in seaports. The types of construction of sea walls, of many materials, and on the widest range of foundations, especially upon soft ones, are considered, while less expensive methods of slope paving and protection are also described. The art of holding dunes by planting is also considered.

The sixth part, being the last in the first volume, treats of agricultural matters, especially drainage and irrigation. It contains interesting sections of the pumps actually in use for drainage purposes in the Holland polders and elsewhere. The description of tide gates is particularly interesting. The reclamation and cultivation of peat lands is also considered.

The second volume treats of works in the direct service of commerce. In it, in the seventh part of the whole work, ship and boat construction, both for river and sea traffic, is considered. It contains many interesting statistics of the development of shipping throughout the world. It treats of sailing, of the resistance of ships in water, and of propellers. It also treats of lighthouses, light-buoys and other aids to navigation. The towing of barges in canals is discussed in an interesting way and the section of canals with reference to ease of towing and ease of maintenance is considered. Sections of many canals as first built, and as afterward modified through the action of the water, and by maintenance are shown.

The eighth part treats of locks. The stability of lock walls and lock foundations is considered, and many interesting constructions are shown to meet the difficulties of bad foundations. Lock gates and the best methods of their construction are described, with many appliances to secure ease and rapidity of operation, and water-tightness. The methods of control of the flowing water in German works are fully reflected. Other means of lifting ships where the difference in level is great are described, with drawings of actual and proposed works.

The ninth part teaches of the canalization of rivers and of ship canals. A description of the Kaiser Wilhelm Canal, as originally built and as subsequently enlarged, and with the modifications that have come about through experience in its operation, is most interesting. The feeding of canals and methods of making the canal bed water-tight and preventing loss of water, are discussed. Methods of protecting canal shores on various kinds of material are described. Overflows, fishways, bridges and aqueducts are considered, as well as canal tunnels.

The tenth and last part treats of harbors and of the appliances for loading, unloading and handling freight. Harbors on rivers are first considered and the manner of handling barges and steamboats on the shores of rivers with varying levels, and often with swift currents, is considered. The extent of the artificial harbors described in connection with many of the German rivers is surprising. The larger German ocean harbors are then described and the general principles of successful arrangement are discussed. The construction of docks, piers, warehouses and freight-handling machinery are all taken up. Dry-docks and floating docks are discussed and some idealized schemes for the transfer of freight between railroads and steamships are shown. The construction of breakwaters is described, with many examples. French, English and Russian practice is freely drawn upon, and occasionally examples from America and other parts of the world are presented. Pontoons, landing stages and ferry houses are described.

Each chapter is provided with a bibliography. An index serves both volumes.

The author speaks of these volumes as being his life work and dedicates them to the extension of "our beautiful art" for the good of mankind. While the work is primarily devoted to navigation and the allied arts, it is of interest in a broader field, because of the ample data and the excellent examples of safe and sound methods of construction, many of which are capable of being applied in other fields of engineering work.

Theory and Practice of Electrical Measurements

PRINCIPLES OF ELECTRICAL MEASUREMENTS—By Arthur Whitmore Smith, Junior Professor of Physics, University of Michigan. New York and London: McGraw-Hill Book Co., Inc. Cloth; 5x8 in.; pp. xiv+243; 99 text illustrations. $2, net.

Prof. Smith has here combined in one handy little volume an elementary treatise on fundamental electrical concepts and a laboratory manual in the simpler electrical measurements. The very combination of such functions has led to some criticism of such books as interfering with the inductive scheme of instruction and as dampening originality and inquisitiveness. However valid such criticisms may be in general, this work is justifiable as a review of principles and an aid to developing technique. It must be remembered that the really basic ideas involved, in this case, should have been discovered through earlier laboratory work with consequent prior cultivation of the student's investigative spirit. The author quite evidently is a modernist in teaching physics, though his writing a combined text might lead a few to think otherwise.

Direct information seems to have been limited to the minimum so that the maximum can be obtained by the student's observation. The arrangement of work is well adapted to the developing experience of the student, beginning with the use of such simple everyday instruments as ammeters and voltmeters. The next work is done with the ballistic galvanometer—which practice may surprise some teachers. The use of current galvanometer and Wheatstone bridge follows. Then current measurements are taken up again by methods involving the tangent galvanometer, electrolysis, Kelvin balance and electrodynamometer. Similarly potential measurements are enlarged upon through the potentiometer. Then power measurement is approached. The somewhat difficult theory of the ballistic galvanometer is presented as one phase of the measurement of capacity. Not until all this work is

passed is the magnetic circuit seriously involved. It is evident that the author has worked out his elementary presentation of this very carefully; his work here can be scrutinized with profit by numerous younger teachers who do not find that their students are acquiring a satisfactory grasp of magnetic phenomena.

While the most of the work throughout such a course is done with steady currents and single impulses, yet alternating currents are not wholly disregarded for, toward the end, the author gives work in measurement of inductance, and discusses effective, instantaneous, average and mean-square values of currents, etc.

Stress Formulas for Simple Frames with Stiff Angles

REVIEWED BY LEON S. MOISSEIFF*

RAHMENFORMELN, Gebrauchsfertige Formeln für einhüftige, zweistielige, dreieckförmige und geschlossene Rahmen aus Eisen- oder Eisenbetonkonstruktion nebst Anhang mit Sonderfällen teilweise und ganz eingespannter Träger—Von Dr.-Ing. A. Kleinlogel, Privatdozent an der Techn. Hochschule Darmstadt. Berlin: Wilhelm Ernst und Sohn. Paper; 7x10 in., pp. x + 351; 338 illustrations. 11 marks.

The book is a collection of formulas for the determination of stresses in elementary frames without diagonals, consisting of two, three and four members with stiff angles and sometimes with fixed abutments. It is the stiffness of these angles which introduces statical indeterminateness in the otherwise so simple analysis. When the connections between two adjacent members are actually hinged or are merely so considered, the elastic behavior of one member is independent of that of the other. With the realization of stiff angular connections the behavior of the entire framework affects each of its members. As long as steel was practically the exclusive material used for such frames, it was of small importance to determine the stresses to any considerable degree of accuracy, and the statical assumptions with their approximate results were sufficient, except where important trusses were built up of a number of such elementary frames without diagonals. The great resistance of the material to compression as well as to tension allowed of such approximations. With the advent of reinforced concrete as a structural material, the use of frames without diagonals became much extended, and in the same time the very low resistance of concrete to tensile stresses and its required reinforcing by steel made a fairly close determination of resulting stresses imperative. A number of monographs have in consequence been published, treating of the simple as well as of the more complicated cases. Dr. Kleinlogel, who is well known by his research work in reinforced concrete, brings forth a volume containing 169 cases of frames subject to various loadings often met in practice.

For each case are given the expressions for the reactions and the moments at the fixed points, as well as those at any section. The frame and its respective load are shown clearly on a diagram, and for each case the moment curves are shown drawn in proportion to an actually computed example. These moment curves show at a glance the flexural condition of the frame and enable the engineer to compare at sight the effect of various loadings.

The author neglects to give the deduction of any of the formulas, nor does he state the assumptions and simplifications made by him. While the formulas can easily be deduced by the aid of the principle of least work, and the simplifications made in them can be then discovered, a collection of formulas is intended for ready use and the busy engineer should be fully informed of the assumptions underlying it. These assumptions are all admissible in good practice. The author assumes the same coefficient of elasticity for all members and he neglects the effect of the change of length of the members due to axial force. The effect of shear is, as usual, also neglected.

All cases of simple frames and loadings that can possibly be met in practice are supplied by the author, and designing engineers will find the book very helpful whenever they may wish to know the stresses in simple stiff structures.

The book is printed with the text on one side of the page only and is well gotten up. A smaller size in the form of a memorandum book would be more fitting.

ROBERTS-AUSTEN: A RECORD OF HIS WORK—Being a Selection of the Addresses and Metallurgical Papers, Together with an Account of the Researches, of Sir William Chandler Roberts-Austen, Hon. M., Inst. C. E., Inst. Mech. E., Inst. M. & M., Am. Inst. M. E., Late Chemist and Assayer of the Royal Mint; Professor of Metallurgy in the Royal School of Mines; author of "An Introduction to the Study of Metallurgy," and Editor of Griffin's Metallurgical Series. Compiled and edited by Sydney W. Smith, Assistant Assayer at the Royal Mint. London: Charles Griffin & Co., Ltd. Philadelphia: J. B. Lippincott Co. Cloth; 6x9 in.; pp. x + 382; portrait and 23 plates. $6, net.

This is a valuable collection of papers and lectures by a famous English metallurgist. For the sake of unity these papers are grouped under the following heads: "His Work at the Royal Mint;" "The Royal School of Mines;" "The Alloys Research Committee;" "On Iron and Steel;" "Royal Society Papers;" "Royal Institution Lectures;" "Art Metal Work;" ending with a general bibliography of all his works. It is the kind of book which one may pick up at any time and find something interesting to read, for the author was a master of his subjects, well versed in historical as well as practical details, and a writer of clear and entertaining English.

AIR, WATER, AND FOOD FROM A SANITARY STANDPOINT —By Alpheus G. Woodman, Associate Professor of Food Analysis, and John F. Norton, Assistant Professor of Chemistry and Sanitation, Massachusetts Institute of Technology. Fourth edition, revised and rewritten. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 6x9 in.; pp. 248; illustrated. $2, net.

Evidences of a careful revision of this well known and useful elementary handbook appear throughout the volume. The death of Mrs. Ellen H. Richards has removed her familiar name from the title page, advanced Prof. Woodman to senior authorship and made Prof. Norton junior author. For each of the three divisions of the book there is an exposition of the relation of its subject to health and then a presentation of analytical methods. Useful reference lists are given.

STATISTICS OF RAILWAYS OF THE UNITED STATES, 1900-1912—Washington, D. C.: Bureau of Railway Economics. Bulletin 66. Paper; 6x9 in.; pp. 75.

This convenient little booklet of railway statistics should be in the library of all railway engineers who aim to keep themselves posted on the large economic facts that lie at the foundation of their special work. The figures given are compiled from the official statistics collected for the Interstate Commerce Commission, and give many data in a form convenient for use which can be obtained only with great difficulty by the direct use of the Interstate Commerce Commission's reports. Engineers who are fa-

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miliar with Wellington's treatise on the economic theory of railway location and know of the vast amount of labor that was necessary to compile the statistical tables in that work can realize what a boon it would have been to the railway engineers of Wellington's time to have had such complete and accurate statistics as are presented in this volume.

Instruments for Engineering Tests--Reciprocating Pumps

REVIEWED BY WINSLOW H. HERSCHEL*

TECHNISCHE MESSUNGEN bei Maschinenuntersuchungen und im Betriebe. Zum Gebrauch in Maschinenlaboratorien und in der Praxis.—Von Prof. Dr.-Ing. A. Gramberg. Third enlarged and revised edition. [Maschinentechnisches Versuchswesen, Vol. I.] Berlin; Julius Springer. Cloth; 6x9 in.; pp. xi + 409; 295 text figures. 10 Marks.

DIE KOLBENPUMPEN einschliesslich der Flügel- und Rotationspumpen—Von H. Berg. Professor an der Kgl. Technischen Hochschule, Stuttgart. Berlin: Julius Springer. Cloth; 6x9 in.; pp. ix + 438; 488 text figures and 14 folding drawings. 14 Marks.

The mechanical laboratories of technical schools have had a slower and somewhat different development in Germany than in the United States, since the testing of materials is confined almost entirely to the government laboratories. This difference of ideal is reflected in German literature. It may be safely said that there is no book in German which covers the ground of Carpenter and Diederich's "Experimental Engineering," though Professor Gramberg has made a good start in that direction. His first edition was issued in 1905 with 222 pages, and this has now grown to nearly double the size. It serves as an introduction to a second volume, which the author hopes to publish very soon, on the testing of machinery, the two volumes together covering the ground of "Experimental Engineering," with the exception of testing materials.

The first volume, which we have at hand, covers its more restricted field very thoroughly. After preliminary consideration of the degree of accuracy attainable in measurements in general, separate chapters are devoted to the different quantities which occur in tests, generally without reference to the machines to which they apply. We have thus a handbook of the theory and use of engineering instruments for determining pressure, velocity, temperature, heating value and the various other quantities which have to be known in testing machinery.

The author has taken care to avoid a mere compilation from manufacturers' catalogs, his descriptions giving not only the action of the instruments, but also the principles and cause of their operation. The illustrations are mostly cross-sections which show the inner mechanisms, in marked contrast to many catalog illustrations which show only the supports and casings, and are unfortunately so frequently used in books of this kind.

Mention is made of all the latest instruments, such as liquid and electric tachometers, water brakes and throttling calorimeters, though the names of the designers and manufacturers may be unfamiliar to us. Dynamometers of all kinds are described, with the exception of belt dynamometers which are dismissed with the remark that they are seldom used in practice though often described in literature. Among instruments less often seen in this country might be mentioned the recording tachometer, automatic prony brakes which give a constant resisting moment, mirror instruments for finding the direction of a tangent to a curve, and steam meters for variable pressure. The last 11 pages give a valuable bibliography, divided into sections, each referring to a chapter of the book.

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A German book, "Die Pumpen," by K. Hartmann and J. O. Knoke, appeared in its third edition in 1906, revised by Professor Berg. It contained descriptions of every device in common use for raising liquids. The development of new types of pumps has been so rapid in recent years, that it is no longer possible to consider them all in one volume. Centrifugal pumps alone require a large volume for adequate treatment. Hence in the present book, Professor Berg confines his attention, except in the last 21 pages, to reciprocating pumps, and we must look elsewhere for descriptions of other means of raising water, such as hydraulic rams, compressed air and the d'Auria and Humphreys pumps.

The distinguishing feature of the book is the thorough treatment of the determination of the proper size of air chambers and valves, both subjects concerning which there is a scarcity of printed information. The author has made an elaborate investigation of the relation between variations of pressure in the air chamber and changes of velocity in the discharge pipe. His method of determining the size of air chamber also takes into consideration the excess pressure in starting. This determines the maximum power of the pump motor and may be of considerable importance in cases where the delivery pipe is of great length and the pressure head comparatively low.

In the section on the theory of valves, the author describes experiments of his own which led to the very interesting conclusion that no matter with how great a velocity a valve approaches its seat, there will be no hammering as long as the water has no other exit except past the valve. In further experiments with ring valves it was found that a valve, loaded with a given spring, was raised a certain height, depending on the quantity of water discharged, but irrespective of what combination of piston area, stroke and speed of the pump produced that discharge.

The section devoted to constructive details is generously illustrated with cross-sections giving the most important dimensions, as is the following section where the various types of piston pumps are considered. The pumps with oscillating piston, which moves through 90 or in some cases 180 degrees, are usually operated by hand power, and have little to recommend them except their low first cost. Rotary pumps, in which the piston moves through a complete circle, are well known in this country.

"Die Kolbenpumpen" is a book which gives much too detailed information for use as a textbook. It would be valuable as a book of reference in technical schools, and should be in the hands of anyone who specializes in the design of piston pumps.

An interesting report on "Labor Conditions on European Municipally Owned Railways," by W. D. Mahon and L. D. Bland, occupies 18 closely printed pages in the 1914 Report of the Executive Council of the American Federation of Labor (Frank Morrison, Secretary, 801 G. St., N. W., Washington, D. C.). The report is based on a trip begun in June, 1914, and covering various

European countries. The conclusions are: That the "street railway service" of the European countries visited "is inferior to ours in many respects," both as regards service to the public and treatment of employees; and that where European "tram workers" enjoy "advanced wage and labor conditions their trade unions were responsible for them," whether dealing with a private corporation or with a municipality.

An English Engineers' Calculus

REVIEWED BY LEWIS E. MOORE*

THE CALCULUS FOR ENGINEERS—By Ewart S. Andrews, author of "Theory and Design of Structures"; Lecturer in Theory and Design of Structures at Goldsmiths' College, New Cross, and H. Bryon Heywood. [The Broadway Series of Engineering Handbooks, Vol. XIII.] London: Scott, Greenwood & Son. New York: D. Van Nostrand Co. Cloth; 4x7 in.; pp. xi + 269; 102 illustrations. Four shillings, net.

This textbook is an effort to present the calculus as an engineering subject rather than as pure mathematics, according to the authors' statement. They state farther that the point of view has been concrete rather than abstract. The book begins with a three-page summary of the more important "results" that should be known by a student before reading it. These "results" are mostly facts rather than principles.

The process of differentiation and the underlying principles are not touched upon at all in the first three chapters. The first chapter begins with definitions of physical quantities and continues with various graphs, rates, so called derived curves, slopes, and the measurement of areas, the treatment being almost wholly graphical. The second chapter shows how to express various simple laws algebraically and is illustrated by several curves. Chapter three takes up exponential and logarithmic laws. Chapters four and five are devoted to differentiation, the obtaining of slopes, and the determination of critical values and maxima and minima. Chapter six is headed "Systematic Integration" and presents the more commonly used integrals. The next chapter illustrates the application of the principles previously enunciated to numerous problems, such as centroid, moment of inertia, etc. The last three chapters are confined to partial differentiation, differential equations in very brief form, and various special curves.

The principal ground for the claim that the calculus is presented as an engineering subject appears to be that the illustrations and problems are taken from engineering practice. It seems that the problems have rather overshadowed the principles and that the book is somewhat unbalanced in this respect. Too little attention is paid to the philosophy of the subject and too much to illustrations. The book undoubtedly fills a want abroad, but is not suited to the needs of technical students in this country.

CONCRETE PILE STANDARDS. By Hunley Abbott, Assoc. M. Am. Soc. C. E., Vice-President and Chief Engineer of the MacArthur Concrete Pile & Foundation Co. New York: Berrian & Douglas, 22 Thames St. Paper; 9x12 in.; pp. 59; illustrated. 50c.

The main part of this pamphlet is devoted to standard details for pile caps. Following an analysis of a method of design are a number of pages of typical pile-cap details, showing the design of caps for one pile and for clusters of from 2 to 25 piles. In addition, there are drawings detailing the various capping designs for different extraordinary conditions and tables giving the proper dimensions of different types of footings. The last few pages are devoted to standard specifications for piles, method of testing piles, and a brief analysis of how a pile supports its load.

CONCRETE ROADS AND PAVEMENTS. By E. S. Hanson, Editor "The Cement Era"; author "Cement Pipe and Tile." Revised edition. Chicago: The Cement Era Publishing Co. Cloth; 5x8 in.; pp. 338; illustrated. $1.50.

The original edition of this book was reviewed in ENGINEERING NEWS of Oct. 16, 1913. The book is now expanded from 13 to 20 chapters (227 to 338 pages) and is evidently entirely rewritten. Statistics of concrete road construction, brought up to the close of 1913, make the book valuable for ready reference on this type of road building. The chief new matter is on "Economic Methods of Handling Materials," "Experimental Work of the Office of Public Roads" and "How to Promote the Construction of Concrete Roads." One of the most valuable features of the book is a compilation of the different specifications in general use for constructing concrete pavements, including some of the best known patented types.

REPORT ON INDUSTRIAL WASTES FROM THE STOCK YARDS AND PACKINGTOWN IN CHICAGO—Made to the Engineering Committee of the Board of Trustees of the Sanitary District of Chicago, by George M. Wisner, Chief Engineer, and Langdon Pearse, Division Engineer. Chicago: Offices of the Board, Karpen Building. Paper; 6x9 in.; pp. xxii + 346; illustrated.

Two years of operation of a sewage-testing station in the Chicago packing-house district are presented in detail in this report, which is made jointly by George M. Wisner, Chief Engineer, and Langdon Pearse, Division Engineer, of the Sanitary District of Chicago. Credit is given to Dr. Arthur Lederer, Chemist, and to L. C. Whittemore, Resident Engineer. The cost of the testing station was met in large part by the packing-house industries. Coarse screens, several types of fine screens, a grit chamber, Emscher or Imhoff, and Dortmund tanks, chemical precipitation tanks, sprinkling filters, a sludge press and a sludge bed were studied. Particular attention was given to grease recovery, sludge utilization and oxygen required. The object of the tests was to learn how to lessen the burden of organic matter in the main channel of the Drainage Canal and how to prevent local nuisance in branches of the Chicago River, and particularly in "Bubbly Creek." The conclusions were in favor of fine screening at individual plants and sedimentation at a central plant, with the addition of sprinkling filters at another site later on. The report contains many drawings and tables.

BOARD OF SUPERVISING ENGINEERS, CHICAGO TRACTION—Fifth Annual Report Covering Fiscal Year Ended Jan. 31, 1912. Chicago: The Board; Lucius H. Davidson, Secretary. Cloth; 6x9 in.; pp. 267; illustrated.

In addition to what one would expect in such a report, a summary of work and a review of statistics, there is a supplement giving an abstract of the Chief Engineer's specifications for the manufacture of materials, construction, erection and installation of equipment in the re-

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habilitation of traction properties. These specifications are grouped under track and roadway, electric-line construction, buildings and fixtures, power-plant equipment, cars and equipment, and tunnels, subways and viaducts.

MECHANICS OF MATERIALS—By Mansfield Merriman, M. Am. Soc. C. E. 11th Edition. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 6x9 in.; pp. xi + 524; 188 illustrations. $4, net.

In this, the eleventh edition of Prof. Merriman's well known text, a new chapter has been added on testing materials and some new matter on influence lines, curved beams, springs, and moments of inertia in the chapter on miscellaneous discussion.

NEW PUBLICATIONS

[So far as possible the name of each publisher of books or pamphlets listed in these columns is given in each entry. If the book or pamphlet is for sale, and the price is known by the editor the price is stated in each entry. Where no price is given it does not necessarily follow that the book or pamphlet can be obtained without cost. Many, but not all, of the pamphlets, however, can be secured without cost, at least by inclosing postage. Persons who are in doubt as to the means to be pursued to obtain copies of the publications listed in these columns should apply for information to the stated publisher, or in case of books or papers privately printed, then to the author or other person indicated in the notice.]

AMERICAN SEWERAGE PRACTICE: Vol. I, Design of Sewers—By Leonard Metcalf and Harrison P. Eddy. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. x + 747; 328 illustrations. $5, net.

ANNUAL REPORT OF THE SUPERINTENDENT, UNITED STATES COAST AND GEODETIC SURVEY, for Fiscal Year Ended June 30, 1914. Washington, D. C.: Department of Commerce. Cloth; 6x9 in.; pp. 132.

ANNUAL REPORT ON REFORMS AND PROGRESS IN CHOSEN (Korea), 1912-13—Compiled by Government-General of Chosen, Keijo (Seoul), Chosen. Linen; 8x11 in.; pp. 271; illustrated.

ANNUAL REPORTS OF THE WATER-SUPPLY COMMISSION OF PENNSYLVANIA, for 1910 and 1911, and 1912 (in Two Volumes)—South Bethlehem, Penn.: Thomas J. Lynch, Secretary. Cloth; 6x9 in.; pp. 946 and 317; illustrated.

THE CEMENTATION OF IRON AND STEEL—By Dr. Frederico Giolitti, Professor in the Royal Polytechnic of Turin. Translated from the Italian by Joseph W. Richards, Professor of Metallurgy at Lehigh University, and Charles A. Rouiller, Assistant in Chemistry at Johns Hopkins University. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. xv + 407; 155 illustrations. $4, net.

CONSTRUCTION OF MASONRY DAMS—By Chester W. Smith, Consulting Engineer. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. xi + 279; 68 illustrations. $3, net.

A DEEP WELL AT CHARLESTON, S. C.—By Lloyd William Stephenson. With a Report on the Mineralogy of the Water by Chase Palmer. Washington, D. C.: U. S. Geological Survey. Professional Paper 90-H. Paper; 9x12 in.; pp. 26.

THE GLACIER NATIONAL PARK: A Popular Guide to Its Geology and Scenery—By Marius R. Campbell. Washington, D. C.: U. S. Geological Survey. Bulletin 600. Paper; 6x9 in.; pp. 54; illustrated.

GRAPHICAL DETERMINATION OF SAGS AND STRESSES FOR OVERHEAD LINE CONSTRUCTION—By Guido Semenza, Local Honorary Secretary of Am. Inst. E. E., for Italy; Consulting Engineer and Technical Adviser of Societa Edison of Milan, and Marco Semenza, Electrical Engineer, Milan. Translated from the Italian by C. O. Mailloux, Past-President, Am. Inst. E. E., Consulting Electrical Engineer. New York and London: McGraw-Hill Book Co., Inc. Cloth; 9x12 in.; pp. x + 24; 13 charts. $3, net.

GYPSUM IN CANADA; Its Occurrence, Exploitation and Technology—By L. H. Cole. Ottawa: Mines Branch, Canada, Department of Mines. Paper; 6x9 in.; pp. 256; illustrated.

HANDBOOK FOR HIGHWAY ENGINEERS, Containing Information Ordinarily Used in the Design and Construction of Roads Warranting an Expenditure of $5000 to $30,000 per Mile. Part I. Principles of Design. Part II. Practice of Design and Construction. By Wilson G. Harger, M. Am. Soc. C. E., First Assistant Engineer, New York State Department of Highways, and Edmund A. Bonney, Chief Draftsman, Division No. 5, New York State Department of Highways. New York and London: McGraw-Hill Book Co., Inc. Leather; 4x7 in.; pp. xiv + 493; illustrated. $3, net.

Errors in the first printing (reviewed in our issue of Jan. 16, 1913) are here corrected.

HISTORY OF RENSSELAER POLYTECHNIC INSTITUTE, 1824-1914—By Palmer C. Ricketts, M. Am. Soc. C. E., President and Director of Rensselaer Polytechnic Institute. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 6x9 in.; pp. xii + 269; illustrated. $2.50, net.

HOW TO RUN AND INSTALL GASOLINE ENGINES—By C. von Culin. 1915 Enlarged Edition. New York City: Norman W. Henley Publishing Co. Paper; 3x6 in.; pp. 96; illustrated. 25c.

INSTALLING EFFICIENCY METHODS—By C. E. Knoeppel. [Works Management Library.] New York: The Engineering Magazine, 140 Nassau St. Cloth; 7x10 in.; pp. viii + 258; 103 illustrations. $3.

MASTER CAR BUILDERS' ASSOCIATION—Report of the Proceedings of the 48th Annual Convention, Atlantic City, N. J., June 10-12, 1914. Chicago, Ill.: Joseph W. Taylor, Secretary, 1112 Karpen Building. Vol. 48—Parts I and II. Cloth; 6x9 in.; pp. 459 and 968; illustrated.

METAL-MINE ACCIDENTS IN THE UNITED STATES DURING 1913—Compiled by Albert H. Fay. Washington, D. C.: Bureau of Mines. Technical Paper 94. Paper; 6x9 in.; pp. 73.

PRACTICAL STAMP-MILLING AND AMALGAMATION—By H. W. MacFarren, author of "Textbook of Cyanide Practice," "Mining Law for the Prospector, Miner and Engineer." Third edition. With a Chapter on Arrangement and Construction Costs of Stamp-Mills by Charles T. Hutchinson. San Francisco: Mining and Scientific Press. London: The Mining Magazine. Cloth; 6x9 in.; pp. 231; illustrated. $2.

THE PRESERVATION OF STRUCTURAL TIMBER—By Howard F. Weiss, Director, Forest Products Laboratory, U. S. Forest Service. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. xiii + 312; 32 illustrations. $3, net.

PROCEEDINGS OF THE SIXTH NATIONAL CONFERENCE ON CITY PLANNING, Toronto, May 25-27, 1914. Boston, Mass.: Flavel Shurtleff, Secretary. Cloth; 6x9 in.; pp. 361.

REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY, for Fiscal Year Ended June 30, 1914—Washington, D. C.: War Department. Paper; 6x9 in.; pp. 1565; illustrated.

REPORT ON IRON CANYON PROJECT—By the Office of the U. S. Reclamation Service at Portland, Ore., October, 1914, and Report by Board of Review Appointed by the Secretary of the Interior, November, 1914. Washington, D. C.: U. S. Department of the Interior. Paper; 6x9 in.; pp. 147; illustrated.

A report made by the engineering department of the U. S. Reclamation Service, under the direction of E. G. Hopson, in coöperation with the Iron Canyon Project Association, composed of landowners, county authorities and others in the northern part of the Sacramento Valley, discusses a plan for a storage-reservoir irrigation system to irrigate 200,000 to 300,000 acres of land.

STANDARDIZATION OF NO. 200 CEMENT SIEVES—By Rudolph J. Wig and J. C. Pearson. Washington, D. C.: Bureau of Standards. Technologic Paper 42. Paper; 7x10 in.; pp. 51; illustrated.

THE TRAVELING ENGINEERS' ASSOCIATION—Proceedings of the 22d Annual Convention, Chicago, Sept. 15-18, 1914. Buffalo, N. Y.: W. O. Thompson, Secretary, care N. Y. C. Car Shops. Leather; 6x9 in.; pp. 473; illustrated.

TYPES OF STORMS OF THE UNITED STATES AND THEIR AVERAGE MOVEMENTS—By Edward H. Bowie and R. Hanson Weightman. Washington, D. C.: Weather Bureau. Monthly Weather Review Supplement 1. Paper; 9x12 in.; pp. 37; 114 charts.

USE OF WATER IN IRRIGATION—By Samuel Fortier, Chief of Irrigation Investigations, Office of Experiment Stations, U. S. Department of Agriculture. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. xiii + 265; 71 illustrations. $2, net.

VITRUVIUS: THE TEN BOOKS ON ARCHITECTURE. Translated by Morris Hicky Morgan, late Professor of Classical Philology in Harvard University. With Illustrations and Original Designs Prepared under the Direction of Herbert Langford Warren, Nelson Robinson, Jr. Professor of Architecture in Harvard University. Cambridge, Mass.: Harvard University Press. Cloth; 7x10 in.; pp. xiii + 331; illustrated. $3.50, net.

WATER-SUPPLY PAPERS, U. S. GEOLOGICAL SURVEY—Washington, D. C. Paper; 6x9 in.; illustrated.

No. 326: Surface Water-Supply of the United States, 1912; Part VI. Missouri River Basin—By W. A. Lamb, Robert Follansbee and H. D. Padgett. Pp. 375.

No. 329: Surface Water-Supply of the United States, 1912; Part IX. Colorado River Basin—By Robert Follansbee, E. A. Porter and H. D. Padgett. Pp. 238.

No. 335: Geology and Underground Waters of the Southeastern Part of the Texas Coastal Plain—By Alexander Deussen. Pp. 365; 5 Plan and Profile Maps.

No. 344: Deschutes River, Oregon, and Its Utilization—By F. F. Henshaw, John H. Lewis and E. J. McCaustland. Pp. 200; 17 Plan and Profile Maps.

No. 347: Profile Surveys in Snake River Basin, Idaho—Prepared under the Direction of R. B. Marshall, Chief Geographer. Pp. 12; 37 Plan and Profile Maps.

WATER-WORKS STATISTICS OF 38 CITIES OF IOWA WITH METER RATES OF 70 CITIES—By John H. Dunlap, Assistant Professor of Hydraulics and Sanitary Engineering, College of Applied Science. Iowa City, Iowa: The State University of Iowa. University Extension Bulletin 8. Paper; 6x9 in.; pp. 52.

Besides the usual statistics, considerable information on underground supplies, steam and electric pumping plants and costs, and yearly meter charges for 50, 100, 150 and 200 gal. per day are given, the latter alongside flat rates. Larger type, and tables from type, instead of being photo-reproduced from hand-printed manuscript, would have facilitated the use of the bulletin.

WOOD PIPE FOR CONVEYING WATER FOR IRRIGATION—By S. O. Jayne, Irrigation Manager. Washington, D. C.: U. S. Department of Agriculture. Bulletin 155. Paper; 6x9 in.; pp. 40; illustrated.

Presents considerable information on the design, construction and use of wood stave, both field and factory made.

THE "WORLD" ALMANAC ANI ENCYCLOPEDIA for 1915—New York: The Press Publishing Co., Pulitzer Bldg. Paper; 5x8 in.; pp. 928. 25c By mail, 35c.

Field and Office

Placing Concrete in Reservoir Walls by Compressed Air, Montreal

In the construction of a new reservoir for the Montreal Water & Power Co. on Mount Royal, Montreal, Que., the concrete for the walls and for a dam at one end was mixed and placed by compressed air. This process is on the MacMichael system, and the mixer was furnished by the Pneumatic Concrete Mixing & Placing Co. for the contractors, Laurin & Leitch. F. H. Pitcher, General Manager and Chief Engineer of the Water Company, is in charge of the work.

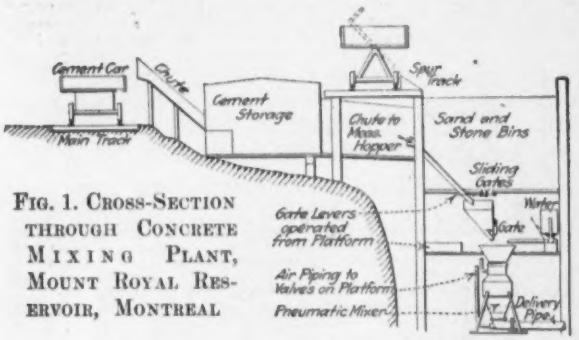


FIG. 1. CROSS-SECTION THROUGH CONCRETE MIXING PLANT, MOUNT ROYAL RESERVOIR, MONTREAL

The mixer had a capacity of ½ cu.yd. of mixed concrete per batch. The air was supplied from a steam-driven compressor located about 1100 ft. from the mixer, in the central power plant, the air being led to the mixer through a 6-in. line, with a storage tank at each end of the line.

Fig. 1 is an approximate section through the concrete plant, and shows the arrangement of tracks, cement shed, stone- and sand-storage bins, measuring hopper, water tank and pneumatic mixer. Cement was unloaded from electric cars on the main track, and the sacks were thrown from the cars into inclined covered chutes which led to the cement shed. For the unloading of sand and stone a standard-gage spur from the main line was laid on a short trestle running past the bins. Stone was dumped directly into the 200-yd. bin over the mixer from 6-yd. side-dump cars. Sand was delivered in box-cars and shoveled into a large auxiliary bin at one side of the mixer, the 90-yd. sand bin over the mixer being fed from the auxiliary bin with a bucket conveyor.

FIG. 3. CORNER OF WALL SHOWING CONCRETING PIPE

In the bottom of the storage bins were sliding gates, operated by hand levers, through which the materials were delivered into the two compartments of the measur-

FIG. 2. INSIDE OF MOUNT ROYAL RESERVOIR, MONTREAL, SHOWING FORMS

FIG. 4. CONCRETING PIPE RISING INTO FORMS ON DAM

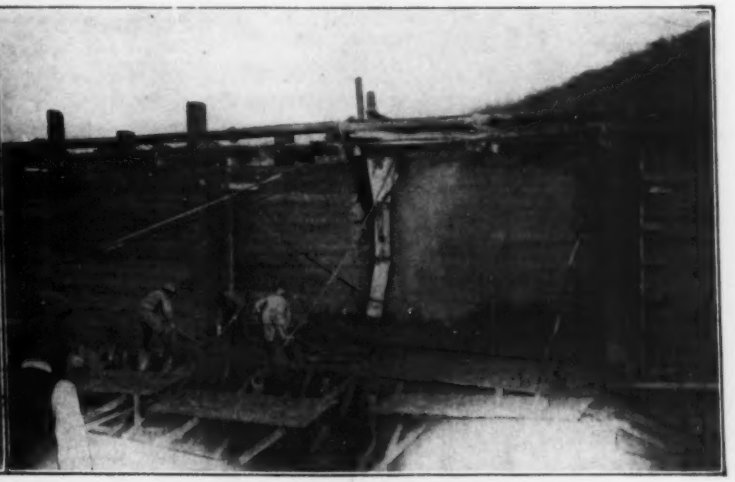


FIG. 5. DEPOSIT CHUTE FROM CONCRETING PIPE TO WALL FORMS

ing hopper immediately over the mixer. The cement was fed from the cement-storage shed by a gravity chute opening into the stone compartment of the hopper. On opening a gate, the contents of the measuring hopper would slide into the mixer and at the same time a measured amount of water was directed against the stream of falling materials, all falling into the mixer chamber together.

The concreting pipe ran from the mixer to the wall forms, where the pipe had a vertical rise of about 37 ft., and continued along the top of the forms around curves to the end. This pipe is 8⅝ in. outside diameter, made of steel, lap-welded, and weighs about 17 lb. per ft. Slip flanges of special design make connection and disconnection an easy matter. At any joint an elbow could be bolted on and the concrete directed into the forms from that point, allowing the stream to shoot directly to the form or employing a "boot-leg" to spread the concrete in wide forms (Fig. 5). The pipe was well tied to the forms at bends, on account of the force of impact of the batches which, traveling at great speed, tend to throw the pipe out of line.

On the dam a derrick, which handled the "plums" used in the wall, shifted the riser pipe from section to section as they were poured, the main pipe being laid on the ground at the foot of the form. Each section was poured in three lifts, the conveyor pipe rising 15, 30 or 37 ft. for the lifts (Fig. 4).

The greatest distance the charges were conveyed was 600 ft. This includes a 37-ft. rise from the ground to the top of the forms at about 100 ft. from the mixer, and curves between the mixer and discharge elbow aggregating 400°. The operation at this distance was slower than at a shorter distance on account of the greater volume of air required to discharge, a pause for the air pressure to rise being necessary between shots.

The gang operating the plant comprised about eight men, including the foreman, distributed as follows: 2 carrying cement to chute and dumping sacks; 2 operating levers admitting materials to measuring hopper; 1 operating water-tank valve and assisting mixer-operator; 1 mixer-operator at air valves and admitting materials to mixer; 1 to 4 at discharge end spreading concrete in wide forms; and 1 foreman. The spreading squad shifted the discharge pipe when necessary.

Progress on the wall was necessarily slow, due to the fact that it was poured in alternate sections averaging about 30 cu.yd. each, which necessitated many form and pipe changes. The average rate on the wall was 100 yd. per shift, which usually filled all available forms. On the dam progress was much faster because of larger sections, the average rate being 250 yd. per day. High rates of pouring were attained, but could not be maintained long owing to lack of material, necessity for changing pipe, or the fact that too much liquid concrete could not be poured into a form at once. On most days the rate of pouring varied from 20 to 50 yd. per hr.

During the time this work was carried on there were days when the temperature was down to zero, but no difficulty was experienced on this account. The water and sand were heated and the operator's platform inclosed. As only a few seconds were required for transit, the concrete went into the forms hot, and in the large masses with heavy forms there was no chance of freezing.

Platting Topography to Distorted Scale (Valuation Board Requirement)

The unusual requirement of the Federal Valuation Board that map features must be platted along the alignment map to be drawn on the lower part of every railway profile sheet, and that this map be drawn to longitudinal and transverse scales of 400 and 200 ft. per in., respectively, presents a new problem in laying off angles and distances. In platting points or objects located by bearing and distance, both angle and distance will be distorted. Therefore, side-shot angles cannot be laid off by protractor and scale. A rectangular building will show rhomboidal on this map, unless it stands parallel to the track.

A method for solving the difficulty of platting is given by Arthur B. Gatrell, of Salt Lake City. The coefficient of correction to angle and distance for any particular angle is readily computed by formulas. These coefficients

may be made into a convenient little table which for any angle gives two figures, one the corrected angle, the other the factor for distance. Such a table is reproduced herewith in condensed form. Its manner of use is obvious, and its convenience will be readily appreciated.

TABLE FOR PLATTING ON A 2:1 DISTORTED SCALE

True Angle	Angle for Platting	Distance Coefficient	True Angle	Angle for Platting	Distance Coefficient
0° 0′	0° 0′	1.000	50° 0′	67° 14′	1.661
5° 0′	9° 56′	1.010	55° 0′	70° 42′	1.736
10° 0′	19° 25′	1.045	60° 0′	73° 54′	1.803
15° 0′	28° 11′	1.096	65° 0′	76° 53′	1.861
20° 0′	36° 03′	1.162	70° 0′	79° 41′	1.910
25° 0′	43° 00′	1.240	75° 0′	82° 22′	1.950
30° 0′	49° 06′	1.323	80° 0′	84° 58′	1.977
35° 0′	54° 28′	1.410	85° 0′	87° 30′	1.994
40° 0′	59° 13′	1.497	90° 0′	90° 00′	2.000
45° 0′	63° 26′	1.581			

If the observed side-shot angle is A, and the angle to be platted is B, then on account of the magnified transverse scale of the plat we must make

$$\tan B = 2 \tan A.$$

If the measured distance is a, and the distance to be platted is b, the value of b is most easily computed after angle B has been found from A, thus:

$$\frac{b}{a} = \frac{\cos A}{\cos B}$$

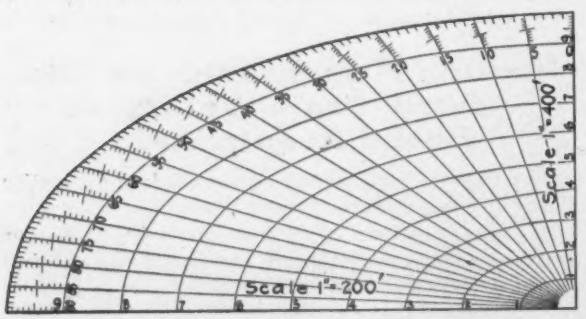
$$= \frac{2 \sin A}{\sin B}$$

$$= \frac{2 \tan A \cos A}{\sin B}$$

whichever formula is most convenient for computation.

For platting a building not parallel to the track, the survey usually gives the angle between one side and the line of sight of the side shot. This observed angle, together with the side-shot angle, gives the angle between building and track, and by the table the corresponding platting angle is found. Then the other side of the building must be treated by the same process as the actual right angle of the building corner will not be a right angle in the plat.

The sketch below shows a protractor for use in 2:1 distorted-scale platting. It was designed by Mr. Gatrell



ANGLE AND DISTANCE PROTRACTOR FOR 2:1 DISTORTION OF COORDINATE SCALES

and R. G. Parmelee, and has proven a great timesaver. The ellipses are drawn every 100 ft., and the last 100-ft. interval is divided to 10 ft. The protractor was made of celluloid. Holes punched through at the 100-ft. marks allow of pricking distances through. The protractor can be used for drawing the curves of wyes.

Concrete Pier Work on the Cumberland Valley R.R. Bridge over the Potomac

The recently completed Potomac River bridge of the Cumberland Valley R.R., at Powells Bend, Md., consists of 12 concrete piers and two abutments supporting thirteen 100-ft. steel spans 9½ ft. deep, and is the longest bridge of its kind over the Potomac. The structure replaces an old bridge and eliminates grade and curvature at this point. It spans the Chesapeake & Ohio Canal as well.

In building the piers in water, double-wall coffer-dams, with the 5-ft. jacket filled with dirt taken from the river bank, were employed. There were nine such piers, standing in from 5 to 10 ft. of water and rising 60 ft. above low water. The river bottom was rock and little excavation was required. Leakage under the coffer-dams was very small.

The foundations for the land piers and abutments were 21 to 25 ft. deep, through clay and gravel, and were put down without unusual difficulty.

The contractor's plant consisted of the 1200-ft. cableway shown in Fig. 2, two derricks, two 50x13-ft. river

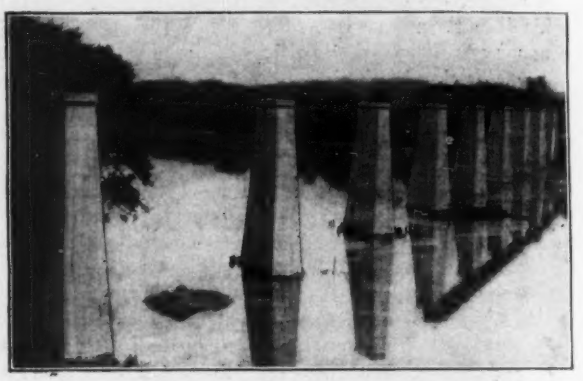


FIG. 1. PIERS COMPLETED AND STEEL ERECTION UNDER WAY

scows, rock drills, and the mixing plant shown in Fig. 3.

At the mixing plant a trestle 200 ft. long by 48 ft. high was constructed for receiving materials, on the West Virginia side of the river. Stone and sand bins were placed beneath the trestle. A quarry was then opened and stone crushers installed. Stone was elevated from the crusher to the stone bin, which was so arranged that in the event of damage to the crusher stone could be dumped into the bin from cars. Practically all the stone, however, was produced locally.

Sand was shipped in drop-bottom cars from Pennsylvania and Maryland, except in very cold weather, when glass sand from Berkeley Springs, W. Va., shipped in box cars to prevent freezing was used. The latter sand has about the consistency of granulated sugar, and is clear of loam and dirt.

As much of the concreting was done in cold weather, it was necessary to provide against freezing, Steam pipes were run through the sand bin. Hot water was used in mixing, and on very cold days steam was turned into the mixer. To prevent freezing at night, salamanders were set on the freshly laid concrete.

The cement was furnished by the railroad company and about a dozen different brands were used. About 10,000 cu.yd. of concrete were used.

The work was done for the railroad under the direction of Thos. B. Kennedy, Chief Engineer; C. Tappin, Engineer of Construction; E. L. Heyser, Resident Engineer, by Thos. Sheahan, contractor, Hagerstown, Md.

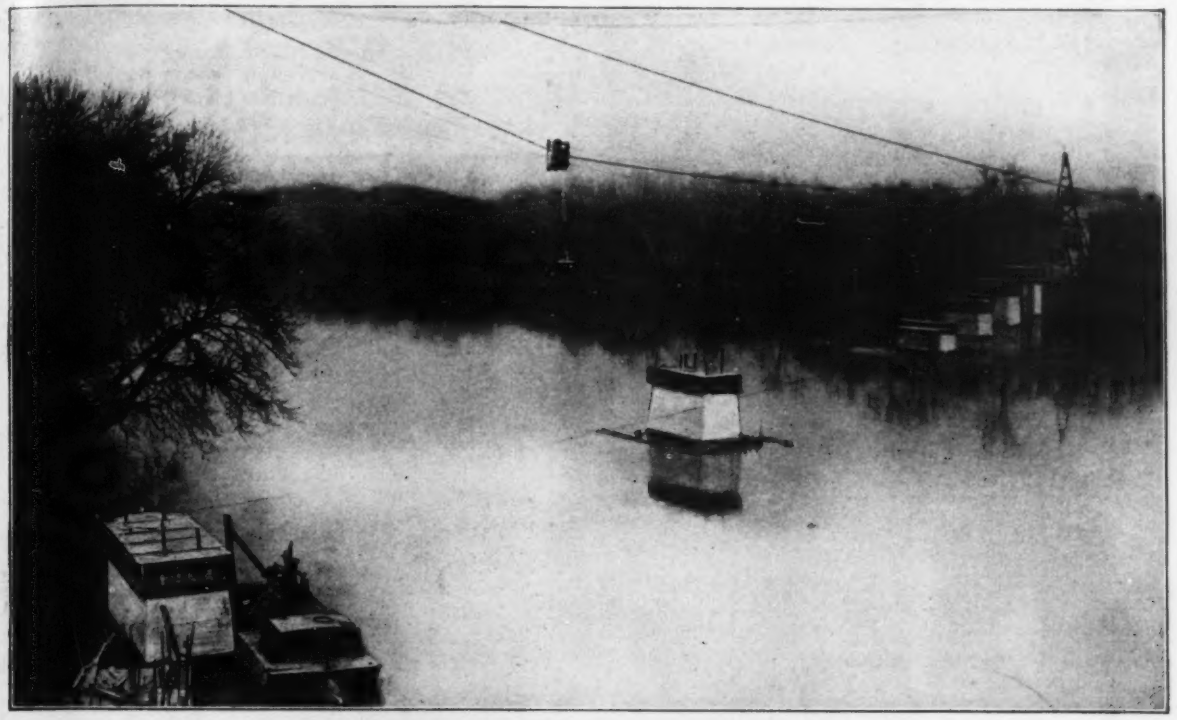


FIG. 2. CABLEWAY IN OPERATION DURING PIER CONSTRUCTION

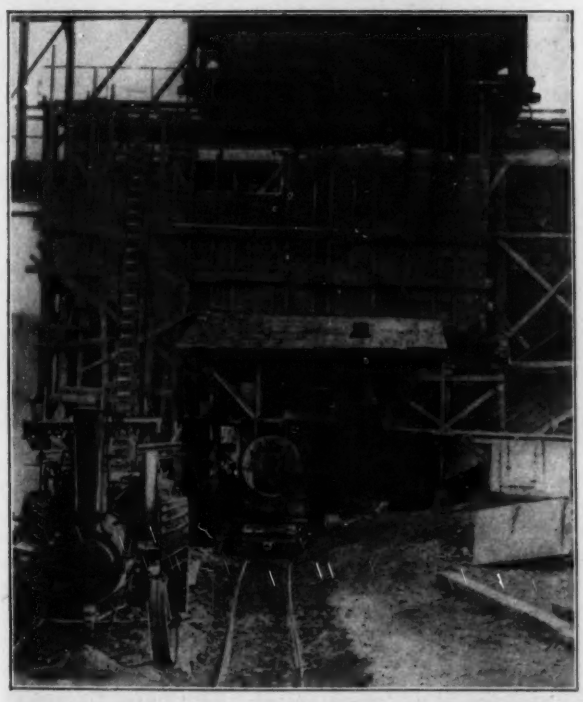


FIG. 3. THE CONCRETE-MIXING PLANT

Test Results with Concrete Waterproofing Materials

The following remarks, extracted from the annual report of the Prussian Testing Laboratory, at Gross-Lichterfelde, just issued (1913 report), give some interesting information on concrete waterproofing materials: Various tests were made on waterproofing and protective material which were claimed to make mortar or concrete water-tight or water-repellent. In most cases, these tests also extended to the question of whether the materials influenced the set or strength of the mortar or concrete. In some cases the applicants made the condition that in testing the material (integral waterproofing material) the permeability test samples should be surfaced with neat cement. This procedure must be condemned, for a test in this way will show not the real resistance of the waterproofing material against water pressure, but the resistance of the surfacing coat. Such a surfacing coat will make the mortar or concrete impermeable even without any special waterproofing addition.

Three mortars were tested for impermeability for the purpose of finding a mortar suitable for use in a water-tight cover of a concrete conduit:

1½ parts (by volume) special water-repellent cement, 7 parts sand; 1 part ordinary cement, ½ part lime putty, 7 parts sand; 1 part ordinary cement, ⅜ parts trass, ⅛ part lime putty, 7 parts sand.

Test specimens made from these mixtures were stored in air (during the first week were moistened daily), and tested under water pressure at 28 days. The first two mortars showed moist spots after two to three days' exposure to 0.7 atmospheres, and soon afterward drops of water began to leak through. The third mortar showed a few moist spots on its lower surface after nine days, but did not become thoroughly wet until the twelfth day.

Testpieces of the same mixtures with a 1-cm. surface coat of 1:3 cement mortar smoothed off with neat cement dusted on remained absolutely impermeable even under a pressure raised to 4 atmospheres. This demonstrates what was above remarked concerning the effect of a neat-cement surface coating.

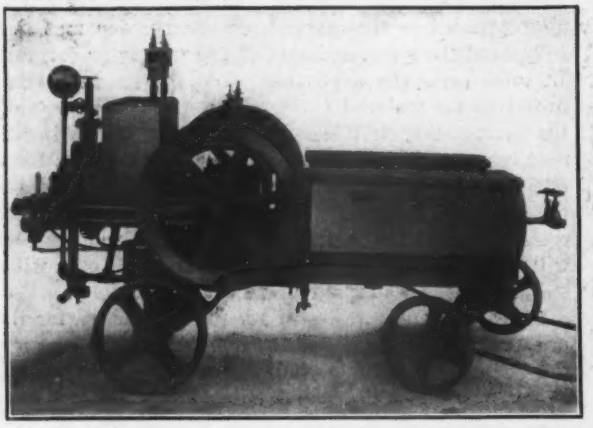
Portable Gasoline-Engine Air-Compressors

The use of compressed-air rock drills, pneumatic tools and other appliances driven by compressed air would be much more general except for the difficulty oftentimes of obtaining a supply of compressed air.

There is, therefore, a large field for portable air-compressor sets, driven by gasoline engines, which can be easily transported to any place on an outdoor job or inside a shop, where a supply of compressed air is desired. Two such portable air-compressor sets are described herewith: one recently designed by the Ingersoll-Rand Co. and a smaller outfit produced by Cris. D. Schramm & Son for stone cutting.

Ingersoll-Rand Outfit—The machinery is mounted on a frame which is supported by iron wheels. A vertical 10-hp. gasoline engine and a vertical compressor, both 5¾x5-in. stroke, have a common crankshaft. The compressor is the company's "Imperial" type—a vertical, self-oiling, inclosed machine, with piston-inlet valves and "Rogler" flat-plate discharge valves. The gasoline engine, being of the two-stroke-cycle type, makes one working stroke per revolution, while the double-acting air-compressor has two working strokes per revolution. A heavy flywheel is therefore used to equalize the motion.

In order to provide cooling water for both the engine and the air-compressor cylinder jacket, an automobile-type radiator is mounted behind the engine with a fan driven by belt from the crankshaft. A vertical air receiver, a battery and tool box, and a 15-gal. gasoline tank complete the outfit.



A Small Gasoline Air-Compressor for Stone-Cutting Work (Schramm)

The engine and compressor are intended to run at a normal speed of 600 r.p.m., which is maintained constant by a centrifugal governor controlling the engine throttle. To provide for variation in consumption of air, an automatic unloader is attached to the compressor and stops the compressing action as soon as the receiver pressure reaches a certain point, automatically throwing it into action again as the receiver pressure falls. This unloader may be operated by hand when cranking the engine so that it starts under no load. The normal air pressure carried is 90 lb. per sq.in.

The entire outfit weighs 1600 lb. and is intended to be moved about in a shop by hand power. For use on outdoor jobs a tongue can be applied for horse hauling. The outfit can furnish sufficient compressed air to drive any one of the following sets of tools: Three chippers, two pneumatic picks, two riveting hammers, one wood or metal drill, two sand rammers, one small plug drill or one "Jackhamer," one medium-sized hoisting engine, ten small stone drills.

Schramm Outfit—The Schramm air-compressor is a much smaller outfit. It was designed especially for monument and general stone-cutting work. The machinery is mounted on an all-metal truck 5x2½ ft. in plan by 2½ ft. high and weighs complete only 750 lb.

The engine is of the four-cycle water-cooled type and develops 2½ hp. at 500 r.p.m. The single-acting compressor is water-cooled and has a cylinder diameter of 3½ in. against 4 in. for the engine. The stroke of both engine and compressor is 4 in. The speed of the engine can be varied from 250 to 500 r.p.m. and the air pressure from 30 to 100 lb.

Air power can be furnished for driving a maximum of three stone-cutting tools. The operating cost is claimed to be about 1½c. per hr. per tool.

A Pontoon Swing-Bridge Over the Panama Canal

A pontoon swing-bridge over the Panama Canal at Paraiso has been built to carry the Panama Railroad over the canal. It comprises short trestle approaches set in recesses in the banks (to maintain a 300-ft. clear channel width when the bridge is open), and a single pontoon 55x378 ft., about 6 ft. deep at the center line, upon which is erected a trestle of framed bents spaced 14 ft. apart. The sills of these trestles are 12x14 ft., 40 ft. long, the six posts of the bent being suitably spread at the foot to distribute the load over as nearly the full width of the pontoon as possible. To give further longitudinal stiffness to the structure, the track stringers (four 10x16, two 8x16) are spliced to be able to act as a continuous truss chord, and corresponding longitudinal members are provided within the barge as bottom chord.

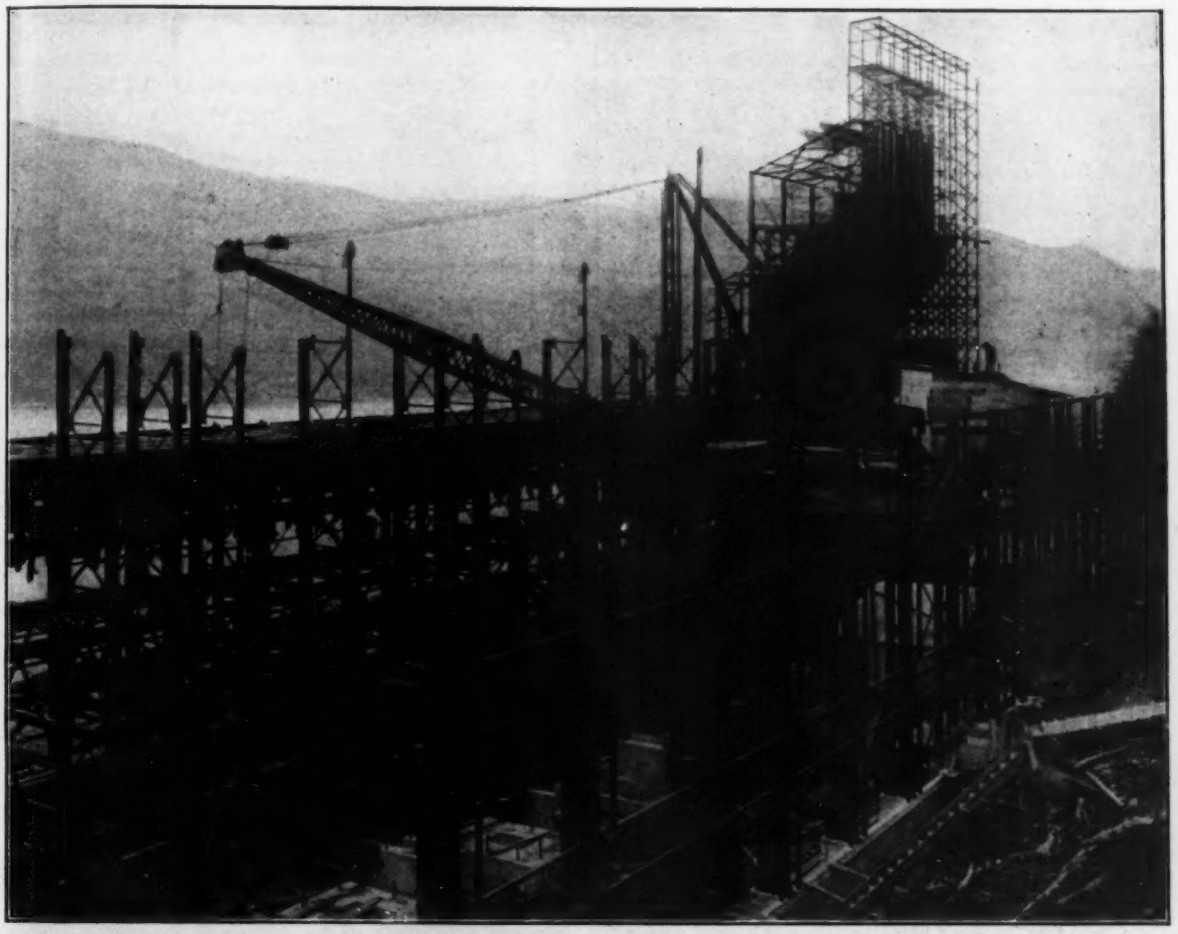
Aprons hinged at either end of the trestle on the pontoon make connection with the approach trestle, resting on the latter. These aprons, 65 ft. long, are made each of two spare lock-gate girders. They are raised and lowered by toggles operated by 7-hp. motors. Hinged rail-connections seating in fixed castings are also provided.

The pivot of the pontoon is at its southeast corner. A vertical pipe 18 in. in diameter is set in the concrete of the east abutment and is engaged by a bronze-bushed steel hinge attached to the bar. The bushing is double coned, so that it can oscillate on the pin. A wildcat on the west end of the pontoon, engaging a chain stretched diagonally across the river, operates the pontoon. The chain has links of 1-in. iron, 5 in. long. A 50-hp. motor drives the 24-in. wildcat wheel. The maximum operating tension on the chain is about 20,000 lb.

The bridge is locked in closed position by an ordinary car-coupler fixed on the outer end of the draw and engaging a vertical jaw-casting set in the west abutment. This casting is a slide 10 ft. high, so that engagement will take place at any water level. An air buffer to take the shock of closing is also provided. All of the operating motions are controlled from an operator's house at the middle of the trestle. [After "Canal Record," Dec. 23, 1914.]

Derrick Mounted on Traveling Cranes for Mill Erection

Mounting a stiff-leg derrick on a pair of traveling bridge cranes was a novel method adopted in the erection of the structural steel for the gold-mill plant of the Alaska Gastineau Mining Co., at Thane, Alaska.



ERECTING STEEL WITH A STIFF-LEG DERRICK MOUNTED ON THE BRIDGES OF TWO TRAVELING CRANES

(Alaska-Gastineau Mining Co., Thane, Alaska. Kansas City Structural Steel Co., Kansas City, Mo., Contractors. Derrick has 100-ft. boom, which in vertical position could place the high material on the right)

This place is on the coast, a few miles from Juneau, where the country is very rough and the mountains slope directly down to the shore, with little or no beach. The problem of erection of this plant was somewhat unusual also, owing to climatic conditions. The topography of the country did not permit of the usual means of handling a large tonnage of steel. The material was brought in by boat to the company's dock, which was close to the site of the buildings. There it was unloaded and hauled up an inclined cable railway to the building site. The only means of handling material at this place was by derricks.

The building for the fine-crushing plant and the mill has a crane runway, designed for 30-ton cranes and running the entire length of the building. The mining company had the bridges for these cranes on the ground, and the contractor for the building erected these crane bridges and placed on top one of his stiff-leg derricks. This derrick with the long boom was able to set this entire section of the building, moving through first to erect the material ahead, and then moving backward erecting the roof structure and top work as it retreated.

The accompanying cut shows the traveling derrick with boom lowered, but with the 100-ft. boom raised to vertical position it was high enough for the erection of the high portion of the structure at the right. The derrick and its engine-house shanty are mounted on a temporary platform carried by the two crane bridges. This traveling derrick was moved by hand power.

The structural steel for this plant, amounting to about 3600 tons, was furnished and erected by the Kansas City Structural Steel Co., of Kansas City, Mo.

NOTES

Socketing a Community Christmas Tree—In December last the Board of Trade of Passaic, N. J., decided to set up the usual community Christmas tree and to have the holiday exercises Dec. 25 to Jan. 1, but found that during the summer of 1914 Main Avenue (East), where the tree has always been located, had been paved with a sheet-asphalt pavement. There being no other available spot in the city the officials of the Board did not know what to do. Finally it was found that a socket,

THE PASSAIC CHRISTMAS TREE SOCKETED IN ASPHALT PAVEMENT OF MAIN AVE.

or holder, could be made by cutting through the pavement and concrete base, digging a pit, and setting in it a section of 24-in. cast-iron pipe concreted in place. The socket thus made, 6½ ft. deep, held the 60-ft. tree firmly without guy wires. When the tree was taken down, an iron cover was put over the pipe, leaving the surface of the street as even and level as any manhole cover. This holder will be kept for similar occasions and purposes.—Colin R. Wise, City Engineer.

A Concrete-Quantity Computer—The Lehigh Portland Cement Co., Allentown, Penn., is sending to any engineer who writes it on a letter-head a celluloid-card circular slide-rule giving the number of barrels of cement, cubic yards of sand and cubic yards of stone per cubic yard of concrete of varying proportions and with different sizes of aggregate. There are four scales, two on either face, for aggregates of 2½-in. stone with most small stone screened out, ¾-in. gravel and under with sand screened out, 1-in. stone and under with dust screened out, and 2½-in. stone and under with dust screened out. The revolving disk is divided into 15 radial lines which show on an inner circle of readings 15 different cement proportions varying from 1 : 1½ : 3 to 1 : 4 : 8, and on the outer circles, through windows in the cover, the corresponding sets of three figures of cement, sand and stone per yard of concrete.

Reading Periodicals in a Large Office—The slip reproduced herewith is used in the engineering department of the Southwestern Bell Telephone System, St. Louis, Mo., to systematize the reading and noting of current engineering articles and make sure that each article will get into the hands of the man whose duties embrace the subject covered by the article. The form reproduced is a multigraph slip of paper 5x6½ in. Such a slip is pasted on the back cover of the periodical when received. A particular periodical is assigned to a given man for first reading and, as the form states, his duty is to mark in the blank spaces below the names of those members of the staff who should read particular articles. This same system in one form or another is used quite widely in large engineering offices. Experience has shown that it can produce highly efficient results, but that it will not do so automatically. Some checking or supervision is necessary to guard against a

SOUTHWESTERN BELL TELEPHONE SYSTEM.

ENGINEERING DEPARTMENT.

Assigned for reading to

Mr._____

This periodical is referred to the above named Engineer, who will be held responsible for its prompt, thorough and careful reading and the reference of it to any other Engineers in the Department who may be interested in, or who should read particular articles which may appear on subjects related to their particular line of work.

Referred to Mr._____See pps.No._____

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Secondary assignment,

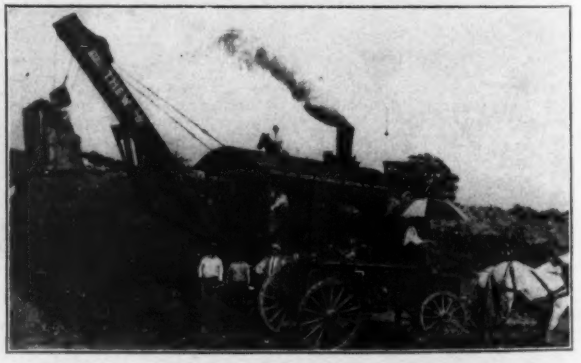
Mr._____Mr._____

Mr._____Mr._____

A PERIODICAL-READING FORM

tendency in times of rush work to neglect entering proper references on the reference slip or to neglect the reading of even important articles. In the organization noted, however, we believe the results are unusually good.

Rapid Handling of Earth with a Thew Shovel—In borrowpit excavation for the embankment of the Milton Dam near Youngstown, Ohio, L. I. Fletcher, contractor, made a new excavation record for Thew shovels. The borrowpit is worked in two lifts, each by a ⅝-yd. shovel. The shovel in the upper lift, shown in the view herewith, made a record of 756 wagon-loads in a single 10-hr. day. These wagons are rated at 1¼ yd. per load. At the time the shovel was cutting through a 12-



BORROWPIT EXCAVATION FOR EARTH EMBANKMENT OF MILTON DAM; SHOVEL WITH RECORD OUTPUT

ft. bank. The best performance of the shovel in the lower lift was 640 yd. The digging is not easy, but the shovel points wear fairly well, two sets of points per season being required. The high-record performance above noted was practically equaled on several other days during the 1914 working season, but was not beaten.

Editorials

Quick Work on the Alaskan Railway Surveys

The appropriation for the Alaskan railway surveys became law Mar. 12, 1914; the appointment of the commission of engineers was announced May 1; by June 1, the organization of 14 field parties was completed and a campaign planned; on June 6 the last party had left Seattle, Wash., for the field of operations. This is a speed record which compares well with the military mobilizations that occurred two months later in Europe.

The season's work of the field parties closed at various dates from Sept. 15 to Nov. 5, with nearly 1000 miles of preliminary survey lines completed, or enough field-work done so that construction work may be begun the coming season. All this was done in a country as yet little explored, during a particularly rainy year. It meant hard work by competent men.

The accomplishments of the field parties and the personal narrative of the chief of one of them, on another page of this issue, will make interesting reading for a lot of full-blooded young engineers, who will probably envy their successful rivals their opportunity to work under the Commission, notwithstanding the hardships of a pioneer Alaskan engineer's life.

"Big Money in the Drafting Profession"

A correspondent calls our attention to a striking advertisement on the cover of one of the February popular magazines which should interest every draftsman, especially those who are out of a job or who are dissatisfied with their lot. The advertisement offers instruction in drafting, and describes the munificent emoluments of the draftsman as follows:

> **There are exceptional opportunities for you to make big money in the drafting profession. It seems as if there never will be enough draftsmen to fill the positions that are open. I will train you to hold one of the big jobs right in your own home during your spare time. YOU can be the man who gets the fat pay envelope; I'll give you the practical training that will put you in the "big money" class. Find out about the golden opportunities that await men who get into the drafting business right away.**

This advertisement certainly abounds in what the professional ad writer calls "punch"; but how about the ignorant youths who are beguiled by this seductive appeal?

It is unnecessary to say to the readers of ENGINEERING NEWS that the statements in the advertisement are essentially false. Possibly the wages of an expert draftsman may look like "big money" to the farm laborer; but when they are compared with the wages paid to workmen in skilled trades, investigations made in one of the most prosperous cities of the country a few months ago showed that the daily earnings of draftsmen in the various machine manufactories were substantially the same as the daily earnings of those working at the machinist trade.

The postal authorities have done a most excellent work in stopping the advertising of fraudulent investment schemes. The laws concerning fraudulent advertising, however, ought to be broad enough to reach those who advertise methods of instruction and seek to make their offer attractive by holding out to prospective students hopes that cannot possibly be realized. Generally, however, laws are not enforced unless someone has enough public spirit to stir up the officers responsible for the enforcement of law and give them the necessary public backing. It is a fair question whether engineering societies might not secure the prosecution of those who insert such advertisements, the tendency of which is to further overcrowd the ranks of the profession, provided the advertisers give such instruction as they claim; and if they do not, their advertisement is certainly fraudulent and ought to be suppressed.

Pavement Expansion as a Cause of Bridge Failure

The remarkable accident on the concrete viaduct at Dallas, Tex., described on p. 92 of our last week's issue, will be studied with interest, we are sure, by every engineer interested in bridge design. The use of wood-block pavement for bridge floors is rapidly increasing and with good reason, since such a floor is lighter than any other form of permanent paving. It is reasonable to believe, moreover, that its smooth surface is of advantage to the structure compared with any rough pavement which produces shock and jar that may be transmitted to the main members of the bridge. It has been generally assumed that the usual insertion of a liberal expansion joint at each side of a wood-block paved roadway was sufficient provision to take care of any expansion that might occur. The unfortunate experience at Dallas shows that this is not the case, at least under the extreme climatic conditions which prevail in Texas.

As has been pointed out in these columns in connection with previous recorded difficulties with expansion of wood-block paving in Texas cities, any pavements in that climate are likely to be subject to long continued extreme heat, coupled with drought and extremely dry atmosphere. When these conditions prevail, often for months at a time, the paving blocks shrink to the last possible degree, and the interstices between them, under the action of traffic, become filled with dust and grit. Such conditions of heat and dryness are apt to be succeeded by heavy rainfall, continuing until the blocks are soaked to saturation.

According to the statement of the County Engineer, published in our last week's issue, a 41-ft. width of wood-block paving on the Dallas viaduct expanded 8 in. This may seem at first sight an impossibility; but computation shows it to be an expansion of only 1.6%, whereas the extreme shrinkage of untreated long-leaf pine from a green to an oven-dry condition, as given in a recent treatise on the mechanical properties of wood, is 6% to 7.6%.

Of course, if wood-block paving were normally subject to any such shrinkage and expansion as 1% even, it would be quite impracticable to use it for street paving. The very fact of its wide and successful use is evidence that no such great amount of expansion takes place under normal weather conditions.

In laying wood-block pavement on a bridge or viaduct, however, in view of the experience at Dallas, it would seem advisable to so design the roadway that any expansion of the pavement cannot bring undue stresses on the structure itself.

Has State Regulation of Public Utilities Been Killed in New Jersey?

The recent decision of the New Jersey Court of Errors and Appeals, setting aside the findings of the New Jersey Utilities Commission in the Passaic 90c. gas case and condemning in part the approval of the State Supreme Court, may mean the practical end of rate regulation in that state.* At any rate it will be counted one of the remarkable decisions of recent years because of the peculiarity and the superficiality of its treatment of franchises and its extremely reactionary attitude when compared with the trend of judicial opinion all over the country. The decision was rendered 6 to 4 and reargument is sought before the entire court of 16 judges. Therefore, the situation is not entirely settled yet.

If there is any one clearly evident tendency in the development of public-utility regulation in this country, it is that franchises are to have a monetary value proportional only to the cost of securing them and the burdens brought by their assumption. Some few of the older franchises may have a considerable monetary value, but this must exist through definitely recorded inducements to undertake certain developments and services. Some eminent jurists hold that most existing franchises can have only an evanescent monetary value, beyond that due to cost and burden, since an unseen sword of Damocles, state power to regulate rates, has always hung over them even though it was for long years neglected and unemployed. In other words, any monetary value that a utility franchise can acquire is due to earnings above ordinary returns on investment and, whenever the state chooses to exercise its right to regulate rates, this surplus of earnings will probably be wiped out. This latest court decision gravely avoids all such considerations. It repeats the old formula with which utility owners have sought to prevent interference with their business (much as the superstitious have chanted their hocus pocus in the face of a storm), saying that franchises are property and hence must have monetary value.

Perhaps the most astonishing part of this decision, and that part which thrusts the knife into the vitals of state regulation, is its repudiation of the modern idea so completely as to quote a rule that the value of a franchise is indicated by the difference between market value of stocks plus floating debt and physical value plus development expense. This rule is repeated hesitantly, but the only trouble the learned court pointed out was that market value might be perverted by stock manipulation. It did not see the equally obvious fact that market value depends on the questioned rates and that if market va is fickle the difference between market value and pl value, which it would constitute franchise value, is equ fickle. The court did not pursue this rule to its log but absurd end, to show that when market value of st plus floating debt is below plant value as in the early velopment years of a utility, franchises have negat value, rates should be put down and the company cut from all hope of ever earning a fair return on its inve ment.

The outcome of this case will be watched with great interest all over the country. If further state court action is unfavorable to the commission, the latter can not carry the matter further. The gas company, however, can, and undoubtedly will, appeal to the Federal courts if it does not secure its ends before state judges. Had the company desired to throttle rate control in New Jersey it could have proceeded in no more effective manner. Yet any freedom gained will probably be short-lived, for its insistence will only urge the people toward the next radical step—public ownership. Even in the remote contingency that the U. S. Supreme Court as now constituted might support the New Jersey court's idea of franchise value, the situation is not helpless. Economic and judicial opinion is progressing and the abandonment of substantial monetary values for franchises in rate cases is no more radical than the admission in 1876 that public interest in private property devoted to public use transcended the vested right secured through franchise contracts.

The Highway Bridge as a Public Engineering Problem

That type of engineering which regards the highest aim of the profession as being close economy, trying to get two cents' worth of results for every one cent expended—the type immortalized in certain standard definitions of engineering—has in the past claimed the highway bridge as falling legitimately within its sphere of operation. Most of our country highway bridges have been built on the basis of the most limited possible estimates of traffic, weight of loadings, probable life, etc. The stress sheet has always been regarded as vastly more important than a sound forecast of load and traffic. With the increase of loads, the coming of heavier rollers, traction and threshing outfits, and motor trucks, many replacements and not a few disastrous failures have resulted.

Unfortunately, the same tendency has prevailed in the design of street bridges in city or suburban territory. The bridge designer has usually thought it within his province to prophesy or even decide whether a particular bridge would or should be traversed by street cars, and in most cases, to make a good showing by a design of low cost, he has decided that street cars would not or should not cross that structure. Frequently, the result has been that street cars did and do cross that structure, and in many a case the existing conditions are properly described as dangerous.

In considering such a subject as that dealt with in the discussion of highway-bridge loadings by Willis Whited, on another page of this issue, it is important to consider a few fundamental facts. Suppose we try to state these facts in simple language:

*This decision was noted briefly in our issue of Dec. 24, 1914; the original commission findings were noted Jan. 23, 1913, p. 185.

A road is a public highway free to the traffic of all persons and all vehicles. A bridge is part of a public road. Any and all road vehicles may therefore pass over any bridge. Many highway bridges, however, are designed for very limited loading, and their strength would be fully taxed by a ten-ton road roller. This state of affairs might naturally be expected to produce frequent accidents and, as a matter of fact, probably no form of structural accident has been more common in recent years than the breaking down of highway bridges by traction engines and threshing machines.

The control of highway-bridge design throughout the country is at present scattered among an enormous number of separate authorities, mainly township or county officials having only the vaguest general knowledge of the nature and anatomy of a bridge. Is it sound engineering to build a highway bridge too weak to carry the loads that the next ten or twelve years will probably develop? Is it sound engineering to let a county commissioner dictate how strong a bridge shall be built, in disregard of existing or future conditions?

Efficient highway departments now exist in many states, carrying out the provisions of state-aid road construction laws. Most of these commissions have capable bridge engineers who supervise the construction of bridges on state-aid roads. What is more natural than that these same officials should fix safe minimum requirements for *all* bridges in the state?

Whatever may be thought of the suggestion that the state highway commissions should design or approve the design for all bridges—in other words, however much we may object to state control over such a purely local matter as a township bridge on a township road—we think no sound objections can be made to the claim that at least *these commissions should prescribe the minimum design loadings* for all bridges. The township roads may indeed have their surfacing determined wholly by the township officials; should that road later come into the state-road system, new surfacing will be required in any event. The bridge, however, on that same road, will not be replaced, but will pass over unchanged from local service to through-traffic service on a state highway, and in proportion to its weakness it will be a limitation and a hampering factor in the state-road system. Such an objectionable result would be forestalled if the state commission were given authority to prescribe loadings for highway bridges *of all classes* throughout the state.

Moreover, even today the state-road system is in no way physically separate from the network of town and county roads. The same kinds of traffic move over roads whether under state or under local jurisdiction. The same load limitations should apply to both.

Traffic conditions and the nature of road traffic are changing rapidly. Automobile and motor-truck traffic is subjecting highway bridges to a far severer service than was ever contemplated by their designers. The proposal, widely advocated, that all bridges should be plainly marked with their load-carrying capacity, is telling testimony of the fact that a great number of our highway bridges are deplorably weak. As our state governments are at present constituted, the highway department which most of them have established seems the best available means for bringing the situation under control and guarding the public safety.

A Bill To Open the Way for Water-Power Development

For more than half a dozen years, development of water power on the navigable rivers of the United States and in the far West, where the Federal government owns the public lands necessary for power sites and rights of way, has been practically at a standstill. Investors have been unwilling to risk their money in water-power enterprises under present Federal laws and the conservationists have fought against changes in these laws, to give greater privileges to the corporations engaged in water-power enterprise, urging that to do this would be to give away franchises of great value. The Adamson-Shields bill now before the Senate, which is said to have received the approval of the Administration, promises to put an end to the long deadlock and open the way for extensive work in water-power development. We understand that if the bill becomes a law at this session, work will begin within 30 days on the construction of a hydro-electric plant requiring an investment of $10,000,000. It is fair to assume that if the particular financial interest which has this enterprise in view is willing to proceed under the authority of this law, other concerns would be equally ready, so that the coming year might see the investment of fifty or even a hundred million dollars in water-power development. The importance of such an amount of work at this time, when engineering activity in so many other fields is almost at a standstill, can hardly be overestimated.

The question then arises whether the bill can be considered subversive of the public interest. Does it give away valuable public rights which ought to be preserved? Careful reading of the bill does not indicate this. On the contrary, the rights of the public seem to have been well safeguarded.

Very briefly summarized, the bill gives permission to any person who has obtained a permit from the Secretary of War to construct a power plant on any navigable river of the United States. Complete control over the plans, location and construction of any such water-power project is lodged with the Secretary of War and the Chief of Engineers; and in case competing applicants appear for any water-power site, the Secretary is to award the permit to the applicant who is "best qualified to expedite and realize the maximum useful development of all the water resources of the region."

The party receiving the permit must make at his own expense all necessary improvements for the benefit of navigation. The rates charged for power sold must be subject to regulation by the state in which the plant is located, or, if the state has not made provision for such regulation, then the rates, service, etc., shall be subject to regulation by the Secretary of War. The rights granted under the permit are to continue for 50 years, at which time the United States, on one year's notice, may take over the entire property on payment of a fair value, such value to include no allowance for the value of the rights originally granted. The provisions of the act do not apply to dams storing water for irrigation or for municipal supplies, nor to dams on unnavigable rivers which are under the jurisdiction of the Secretary of the Interior or the Secretary of Agriculture. It is further provided that power plants constructed under the act may not be so transferred in ownership as to form an unlawful trust or monopoly.

The sole ground, it seems to us, on which this bill may be opposed by the conservationists is that the United States would be giving away a privilege which ought to yield it a large sum of money during the 50-year term for which the privilege is to continue. If there were indeed an enormous margin of profit in the development of water power and if those undertaking such developments were free to charge such rates as they pleased for power or current, then there might be good grounds for opposition to the bill. Engineers familiar with the commercial side of water-power development, however, well understand that with the present low cost of steam power those who undertake water-power development on a large scale have a difficult task to make profit enough from their enterprises to command the necessary capital for the work. While some water-power enterprises have yielded large profits to their promoters and builders, there are plenty of others scattered over the country in which many millions of dollars have been lost by the investors.

Further than this, however, public-utility regulation by state commissions has now reached such a stage that there need be no further concern regarding the growth of water-power trusts or the giving away gratis of valuable franchises. If a concern is making any excessive amount of profit upon its investment, the fact will soon become known and a strong movement will spring up among its customers for compulsory reduction of the rates charged.

The only doubtful feature in the bill, it seems to us, is whether the giving away gratis of water-power permits which the bill proposes would not lead to a general scramble to secure such permits by irresponsible promoters backed by more or less political influence. The fixing of even a nominal rental for such privileges would tend to eliminate a large class of these and make easier the task of the Secretary in judging which competitor was most competent to develop the power to the best advantage. But if such a rental would prevent responsible companies from proceeding with water development, it would be far better for the public to dispense with it.

Letters to the Editor

Waterways from the Great Lakes to the Atlantic

Sir—Referring to the letter of Frank L. Neall, in your issue of Dec. 17, 1914, p. 1226, one of the provisions of the Barge-Canal law, ratified by popular vote in 1903, reads:

> All fixed bridges and lift bridges when raised shall give a clear passageway of not less than 15½ ft. between the bridge and the water at its highest ordinary navigable stage.

Eleven years after the ratification of this law, Mr. Neall, a transportation expert, for the first time learned of this limitation. One would suppose that he would have been better posted.

To rebuild the bridges crossing the Barge Canal to admit the passage of the Lake Drummond Canal barges, as Mr. Neall proposes, would entail a cost of many millions of dollars. Not alone would hundreds of highway bridges have to be changed, but also a large number of railroad bridges, many with six tracks. Mr. Neall suggests a clearance of practically 30 ft., to which must be added several feet to allow for high water.

Anyone familiar with the topography of the country traversed by the Barge Canal cannot consider such a proposition as anything less than chimerical. In the country it would mean long and in many instances impracticable approaches, and in the cities and towns the virtual abandonment of every fixed bridge and the substitution of lift bridges, entailing a perpetual cost for operation and a constant delay to navigation, as well as to pedestrian and vehicle traffic. When the Ship Canal between Lake Ontario and the Hudson River was proposed some years ago, this feature was fully understood and provision for crossing the canal was made at about 10-mile intervals.

Mr. Neall thinks prompt action is imperative upon the United States and New York State authorities to rectify this palpable (?) engineering mistake. So far as the United States is concerned, Mr. Neall does not seem to know that the United States has no more jurisdiction over the Barge Canal than has his own State of Pennsylvania, the State of New York being supreme in this matter.

When the Barge Canal was designed, the most economical dimensions were considered and it was found that barges of the type in use on the canals since 1825 but of larger dimensions would prove the most economical method of transportation.

Certain misguided people have tried to evolve a mongrel type of vessel, neither "flesh, fish, nor fowl," that could or would navigate the Great Lakes, the Barge Canal and peradventure the Atlantic Ocean, forgetting that each body of water requires a special type of its own.

It must be conceded by the merest tyro that a ship canal will cost more than a barge canal; that a vessel capable of navigating the Great Lakes at a profit will cost more than a fleet of barges; that the latter will require a less expensive crew; and consequently that the cost of carriage must be less for the Barge Canal.

To this cost must, of course, be added the cost of transfer. Except in the case of vessels sailing both the Great Lakes and the Atlantic Ocean, only one transfer is to be considered and that at Buffalo. Great stress has been placed on what is called the excessive cost of this transfer, controlled by the ubiquitous elevator trust of that city. There is no doubt that with modern machinery and appliances the present cost of merchandise transfer (less than 20c. per ton) can be reduced one-half.

As is well known, Canada is spending $50,000,000 on the enlargement of the Welland Canal. This will enable the largest Great Lake freighters to reach Lake Ontario, but no farther toward tidewater. To reach Montreal, there must be an enlargement of the St. Lawrence Canals, at an additional cost of $150,000,000. A transfer at Montreal will be necessary, as no vessel built primarily for service on the Great Lakes can cross the Atlantic Ocean;

and to eliminate this transfer, vessels costing double will have to be used.

A. CARRIER.

Buffalo, N. Y., Dec. 21, 1914.

[Our correspondent presents in condensed form the argument made by Col. Thos. W. Symons when the Barge Canal scheme was adopted some fifteen years ago. That argument *appeared* to prove that barge towing was the cheapest system of water transport. But in the fifteen years since that argument was made and the Barge Canal plans were adopted, the tendency in marine transportation has been away from the towed barge and toward the independent self-propelled vessel.

Further than this, the great bulk of the traffic from the West to the East is not destined to cross the ocean, but for domestic trade. A vessel fit to sail the Lakes is perfectly fit to traverse the Atlantic Coast from Portland to Jacksonville. The theoretical cost of transferring freight is not the whole cost by a good deal. The loss of time of the vessel during the transfer and the risk of breakage, damage and loss during transfer are heavy items in many classes of merchandise.

It is probably true that a real ship canal across the densely populated State of New York would be so serious a barrier to land traffic that it is not likely ever to be built, at least on the route followed by the New York Barge Canal. It would be feasible, on the other hand, to build a ship canal on the alternate route surveyed by the Deep Waterway Commission of 1900 from the St. Lawrence River near the New York State line eastward to the northern end of Lake Champlain, and from the southern end of that lake southward to the Hudson. The Deep Waterway Commission of 1900 estimated the cost of a 21-ft. deep waterway from Lake Ontario to the Hudson by this Champlain route at $141,000,000.

When the Lake shipping interests and the Central West finally determine to have a direct outlet to the ocean without transfer, they can obtain it by this route at smaller first cost and with greater commercial advantage than by any other.—EDITOR.]

Heat in the Edison Fire

Sir—Careful study of your article of Dec. 17, 1914, and the comments in your issue of Jan. 7, 1915, on the results of the Edison fire and the lessons to be learned therefrom, has impressed the writer with the fact that each commentator has emphasized only such ideas as struck him particularly. A correct statement of the whole would, doubtless, include extracts from all.

It is apparent that the degree of heat generated must have been greater than that for which a fire-protected building is ordinarily designed. A greater fire risk is rarely found than this one was, so that, no matter what the result was, it is not quite correct to believe that it is characteristic of the ordinary result of a fire under ordinary conditions. Men familiar with concrete construction can draw lessons from the results of this fire, if they understand the conditions properly, and the conclusions reached will be correct.

The general lesson to be learned from this catastrophe is directly concerned with the degree of heat to which a building is apt to be subjected and the care necessary to provide proper precautions to insure resistance against it. Such matters have not yet been given the proper amount of scientific study. However, the difference in results between the wooden and concrete buildings is surely sufficient to show that we have progressed far along the road. A more scientific study of fire protection would show the necessity of accurately determining the temperatures generated in fires and then carefully determining the details necessary in the different building materials which are proper to use, backing every point by actual test under conditions, as near as may be possible, to the actual fire risk, and selecting then only such details as have passed the test. Thus only is it possible to plan structures to resist conditions that will be imposed upon them and do this economically.

It is a result of the writer's own experience that flat floors, without beams, with rounded columns and column caps flaring out gradually to the ceiling and without sharp corners, unless otherwise properly protected, should and do resist a hot fire longer than any other type of construction.

JNO. A. FERGUSON,
Engineer, Bureau of Building Inspection.
Pittsburgh, Penn., Jan. 11, 1915.

Why Use Yards in Measuring Engineering Work?

Sir—The use of the yard as a unit of measurement of area and volume is almost universal among engineers in the United States when figuring on earthwork, road work and concrete.

Any rational reason for the use of the yard seems difficult to find. The usual explanation given for its use is that as everybody uses the yard, it is necessary to use it in order to compare results with other work.

The use of the yard is probably most annoying and inconvenient in concrete work. The American Concrete Institute has recognized this and has specified that the unit of measure of concrete work should be the cubic foot.

Dimensions on plans are always given in feet and fractions thereof (either tenths or twelfths). Quantities are figured in cubic feet and then converted into cubic yards. If linear measurements can be properly expressed in feet, why is it not proper to measure area and volume in feet also?

It takes a man with a remarkable memory or else a table of quantities to figure promptly the quantities of material required for concrete work of various proportions, when concrete is figured in cubic yards, cement in barrels and aggregate in tons; and these are the usual units employed. It becomes a comparatively simple task when all quantities are estimated in cubic feet.

It might be interesting to estimate the value of time annually wasted on engineering work in converting feet to yards and the chances of error in doing it and then to meditate on what characteristic of the engineering mind leads it into unnecessarily complicating a business which needs simplification wherever possible.

O. W. CHILDS.

4211 Flad Ave., St. Louis, Mo., Oct. 20, 1914.

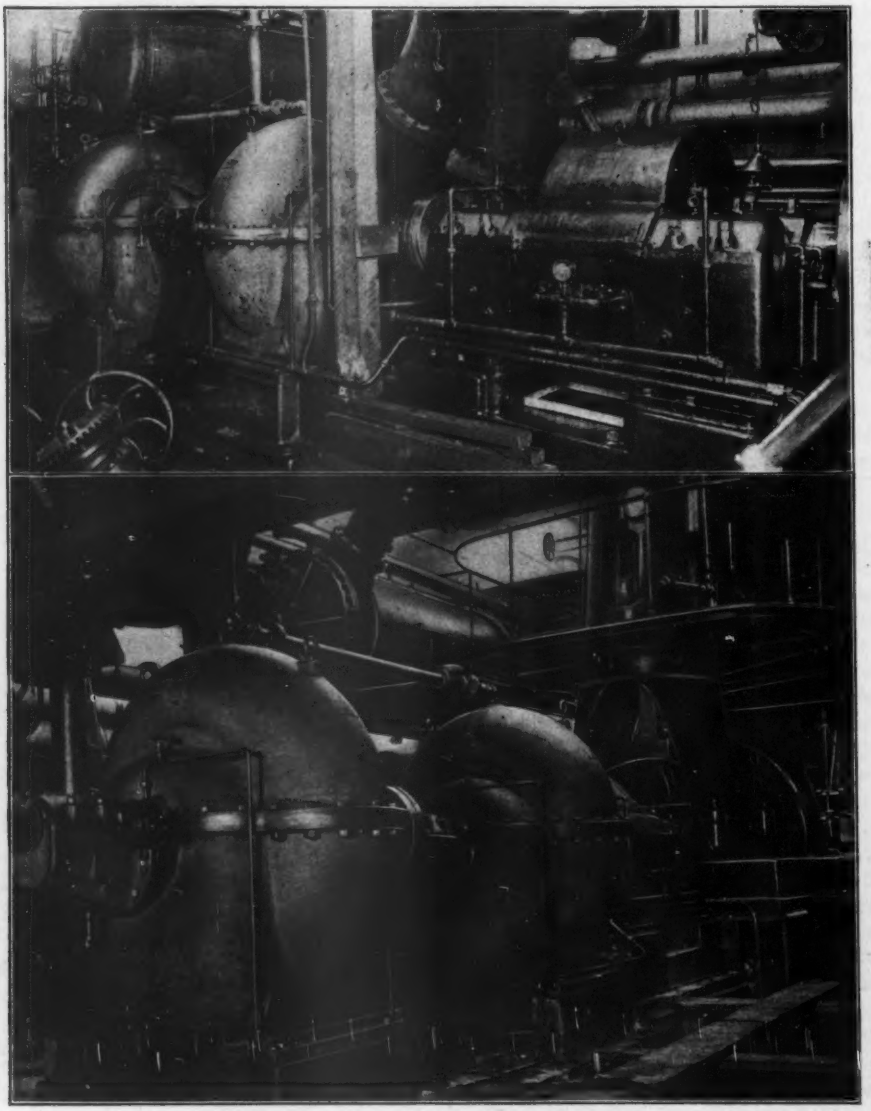
The Vienna Rapid Transit Commission, which controls the Belt Ry. operated by steam locomotives at Vienna, Austria, proposed to convert the line to electric traction and to build a system of subways, some 12 miles in extent, to operate in connection with the main line. Preliminary work was well under way in preparation for this proposed enterprise when it was interrupted by the outbreak of the war.

Direct-Driven and Geared Centrifugal Pumps, Ross Pumping Station, Pittsburgh

Four large centrifugal pumps direct-coupled to compound steam engines in the Ross pumping station of the Pittsburgh (Penn.) water system gave so much trouble during the first six years of operation (1906-1912) that one of them was converted into a small high-speed engine-driven centrifugal pump, and an additional high-speed centrifugal unit was installed, so that the remaining three large pumps are now used only as reserves. The converted unit, using the original engine, has 1:6 *speed-increasing* gears to drive the new centrifugal pump. The new high-speed unit is driven by a steam turbine, and has 10:1 speed-reducing gears to drive the pump. It is very satisfactory and showed high duty on test. Considering the station as a whole, it is not locally regarded as a model, but rather as a makeshift combination.

Ross station is on the north bank of the Allegheny alongside the city's filtration plant at Aspinwall. It supplies the filters with raw river water, and handles an average daily pumpage of 147 million gallons with 50 ft. mean lift, which represents an average power output of about 1300 hp. The original pumping units each comprised a 400-hp. vertical compound engine running at 70 r.p.m. rigidly coupled with a 35-million-gallon centrifugal pump. The pump had an inclosed impeller 11 ft. 3 in. in diameter. Its duty was in the neighborhood of 80 million foot-pounds per 1000 lb. steam.

The impeller shafts broke frequently, and when the fracture occurred inside the bearings the impeller was usually broken too. A spare impeller and shaft were carried in stock all the time, ready for any break, as the draft of water on the system required all four pumps to be in service. Special trouble occurred about three years ago, when a second impeller shaft broke before the first could be replaced. It then was found to be practically as quick a job to reconstruct this one unit on new lines as to wait for a new shaft and impeller of the old type.



FIGS. 1 AND 2. TWO VIEWS OF GEARED ENGINE PUMPING UNIT; ROSS STATION, PITTSBURGH

The main source of trouble in the large pumps was the nature and relation of the bearings. The impeller shaft rested in two lignum-vitæ bearings lubricated with water; the near bearing was less than 2 ft. from the end bearing of the engine shaft, and in this short space the shafts were coupled by a rigid bolted flange connection. As the water bearings of the impeller shaft wore down, they put excess load on the engine bearing and also subjected the overhanging shaft to abnormal bending stress. The breakages were attributed to this bending, coupled with the effects of vibration from imperfect balance of the large impeller. At present, with three of the original four pumps still in use, none of them has its original impeller or shaft, all having broken and been replaced.

PUMPS DRIVEN BY SPEED-INCREASING GEARS

The one old unit which was converted was reconstructed as follows: The entire pump end was removed and two small pumps on a single shaft were set in its place; a set of 1:6 helical gears was placed to connect the engine with the new pump, increasing the speed from 100 r.p.m. at the engine to 600 r.p.m. at the pump. These gears are duplex, of the well known De Laval type, and are inclosed, running in oil. They were chosen with a view

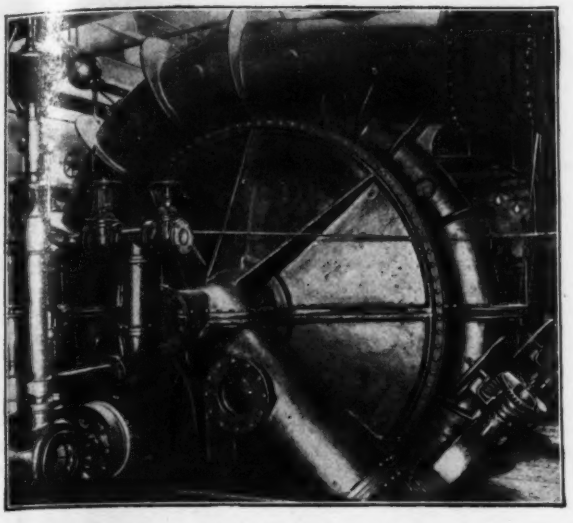


FIG. 3. REPLACED 35,000,000-GAL. PUMP OF ENGINE UNIT

to replacing the engine later by a steam turbine running at 3600 r.p.m., and inverting the gear set to reduce speed 1:6 in place of increasing 6:1. They are of the two-bearing type, i.e., without middle bearing between the two gears of a pair. Between engine and gear is a flexible coupling, and another is placed between gear and pump shaft.

The two pumps on the same shaft have 27-in. impellers, and can handle 25 million gallons each per day; they operate in parallel, so that the unit is of 50 million capacity.

This hybrid unit has worked very successfully in the two years or so since it was fitted up. It gives a duty of about 100 million foot-pounds per 1000 lb. dry steam. However, the department officials expect that the non-uniformity of engine torque will result in undue engine wear sooner or later. The gears run quietly and have given no trouble, although their wear is rather severe, as might be expected; whenever the casing is opened, something like a teaspoonful of very fine cuttings is removed.

HIGH-DUTY TURBINE-DRIVEN PUMP

In 1913, shortly after the conversion of the one old unit, a new 100-million-gallon pumping unit was installed in a clear space in the middle of the building, and this has since carried the principal part of the pumping load. It is a 360-r.p.m. centrifugal pump with single 48-in. impeller, driven by 1:10 speed reduction from a 12-stage impulse turbine of 1200 hp., running at 3600 r.p.m. Both turbine and pump are of De Laval make. The duplex gears in this unit have a middle bearing. As in the converted unit, they are cut off from both power and pump by flexible couplings.

Duty tests of the new unit showed the good figure of 117,000,000 ft.-lb. per 1000 lb. dry steam. This efficient performance, and the smooth running of both ends, have made the whole unit very satisfactory. The service has frequently been interrupted, however, by electrical trouble with motor-driven auxiliaries, especially a vertical-shaft centrifugal hotwell pump. In spite of this, a single uninterrupted run of three months is on record. To avoid similar trouble in future installations, steam-driven auxiliaries will probably be used.

The Ross station is under the city's Bureau of Water (Chas. A. Finley, Superintendent; C. O. Daughaday, Assistant Superintendent).

Selecting the Engineers for the Federal Railway Valuation—A demonstration of the ability of the U. S. Civil Service system to obtain high-class men for technical positions has been made within the past year, in connection with the employment of men for the Federal railway valuation. For this work the Interstate Commerce Commission required men with qualifications ranging all the way from rodman and chainman to senior positions in civil, mechanical, structural, electrical, and architectural engineering, as well as motive-power men and expert accountants. There have been approximately 15,000 applicants for these positions, and the task of sifting the wheat from the chaff and of grading the wheat after the sifting was one of considerable magnitude; but it was done, and it was done so well that the I. C. C. expressed its gratification to find that it could secure a force so well equipped to perform the gigantic task.

For the high-grade positions, where men of experience and attainments are needed, an examination is given which does not require the competitors to assemble at any place or to answer technical questions. They are called upon to furnish under oath a detailed statement of their education and experience, including all the work they have done since graduation. They may also be asked to submit an original thesis or report or published works, and they are required to give the names of persons competent to testify as to their experience and personal fitness. Confidential inquiry is made by the Commission from various sources, as well as of all persons referred to by the applicant.—From a paper by Geo. R. Wales, Chief Examiner, U. S. Civil Service Commission, read at the American Highway Congress.

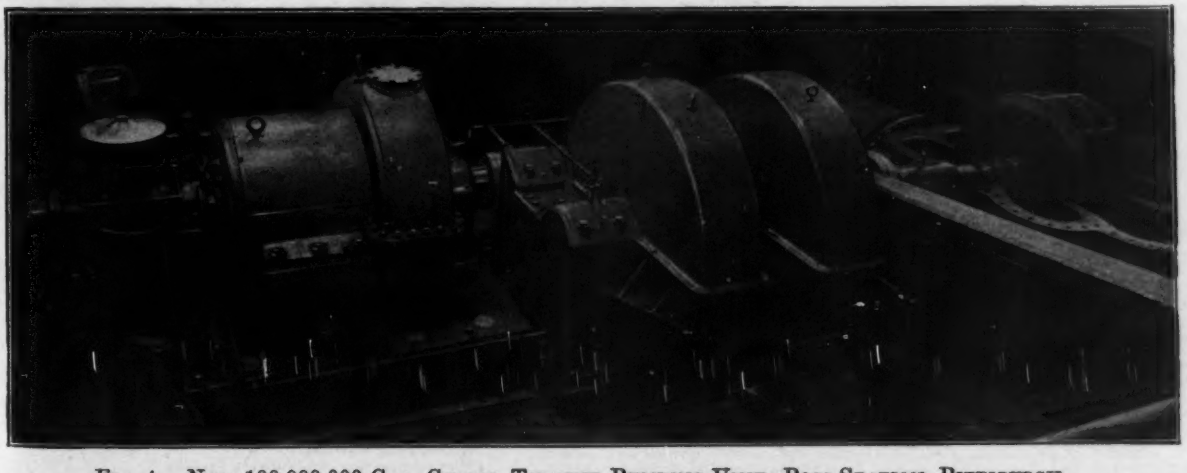


FIG. 4. NEW 100,000,000-GAL. GEARED-TURBINE PUMPING UNIT; ROSS STATION, PITTSBURGH

Tests for Bond and Electrolytic Corrosion of Painted Reinforcing Steel

Proposals to paint the steel reinforcing for concrete have been repeatedly heard since knowledge became clear on the corrosion of imbedded iron subject to electrolytic conduction of stray direct current. Such proposals, however, have been generally scouted because of the believed loss of bond between painted steel and concrete, the expected concentration of corrosion at breaks in the paint film and the partially demonstrated inability of paints to maintain an impervious barrier to moisture and electric current. Recent contributions to knowledge in this field are found in the investigations of H. A. Gardner, Assistant Director of the Institute of Industrial Research, Washington, D. C., described in a lecture before the Master Painters' Association in Philadelphia, Jan. 13, 1915. From Mr. Gardner's paper the appended information is secured, showing that loss of bond is not always necessary with the interposition of a paint film and that not all imbedded paint films immediately lose their insulating properties. By sanding while tacky those paints which dry with a glossy surface, nearly as good bond was secured as with bare steel in concrete.

CORROSION TESTS—Three sets of specimens were made up. The first was made by imbedding two 1x[illegible] painted iron rods in 1:2 concrete cylinders about [illegible] in. Before painting, the rods were thoroughly cleaned of scale and rust; two coats were applied, allowing a week between.

The specimens, after curing for a month, were all set in a shallow pan with sufficient water to immerse the lower 2 in. One rod in each specimen was made a cathode and the other an anode of a direct-current circuit (110 volts cut down by resistance to 30 volts). The current was small. After a week two of the specimens showed small cracks near the bottom, whereupon the cylinders were transferred to separate earthenware jars and immersed to within 1 in. of their top. Nearly every cylinder cracked within 10 days and the fracture in every case started at the anode. Cracked specimens were easily split in two sections, disclosing the rods. The few not cracked were split with a chisel to allow examination of the imbedded metal, as shown in the accompanying figures.

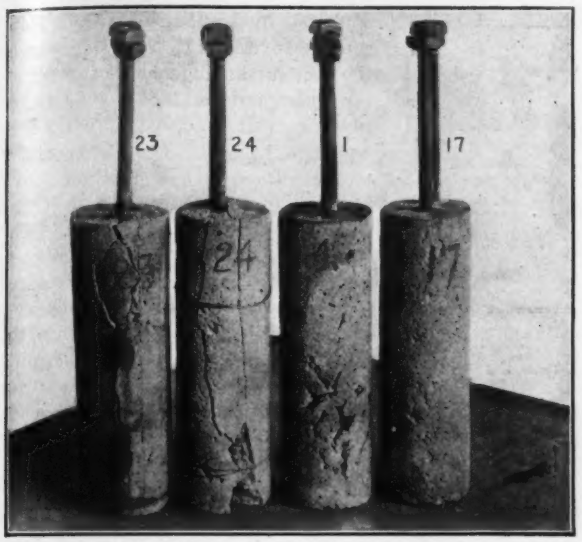
In a second set of test specimens, single ¾x12-in. painted iron rods were placed in 3½x8-in. cylinders. After a month's curing and 24-hr. immersion, the specimens were placed in individual earthenware jars with

TESTS FOR BOND AND CORROSION OF PAINTED REINFORCING STEEL

Specimen	Paint Composition	Corrosion		Comparative Bonding Strength Series III
		Series I, 500 Hr., 2 Rods in 7x21-In. Cyl.	Series II, 300 Hr., 1 Rod in 3½x8-In. Cyl.	1 Rod in 3½x8-In. Cyl.
	Unpainted Blank Specimens			
23	Not painted.	Cracked at 240 hr. Large current throughout test. Anodes badly corroded and pitted.	Cracked at 96 hr. Large current throughout test. Anodes badly corroded and pitted.	2010 lb.
24	Not painted.	Cracked at 50 hr. Badly pitted and corroded.	Cracked at 96 hr. Badly pitted and corroded.	2750 lb.
	Bituminous Paint			
1	Boiled water-free coal tar, lime, portland cement, rosin, and benzol.	No cracking. Only small current. Some excretion of paint at anode.	No cracking only small current.	1530 lb.
17	Blown residual petroleum oil, gilsonite, benzol and turpentine.	No cracking. Only small current.	No cracking. Only small current.	2810 lb.
	Oil Paints			
3	Red lead in raw linseed oil; 30 lb. per gal.	Did not crack but large quantity of iron hydrate at top of specimen.	Cracked at 192 hr. Iron hydrate stain at surface throughout test. Iron badly corroded.	1370 lb.
13	Chrome green (20% on 80% barytes) in raw linseed oil.	Cracked at 240 hr. Iron hydrate stain early. Iron badly corroded.	Cracked at 192 hr. Specimen stained. Iron badly corroded.	790 lb.
14	Blue lead in raw linseed oil; 14 lb. per gal.	No cracking. Slight corrosion. Iron hydrate at surface.	No cracking. Slight corrosion. Iron hydrate on surface.	1250 lb.
15	Chromated iron oxide in raw linseed oil. 12 lb. per gal.	No cracking. Only slight corrosion.	Cracked at 144 hr. Iron oxide at top.	930 lb.
16	Blue lead in heavy-bodied linseed oil reduced with equal quantity of turpentine to give flat surface; thin film.	Small crack at 240 hr. No surface deposit shown. Anode showed considerable corrosion.	Small crack at 216 hr. No surface deposit. Anode corroded.	1400 lb.
27	Chromated iron oxide in treated tung oil. 12 lb. per gal.; "sanded surface."	Not used.	No cracking; only small current; no surface deposit. Excellent condition.	2000 lb.
28	Equal parts 14 and 16; "sanded surface."	Not used.	No cracking.	1880 lb.
29	Asbestine in processed tung oil; "sanded surface."	Not used.	No cracking; only very small current; excellent condition.	Not used
	Aqueous Paints			
4	Silicate of soda 40° Be.	Cracked at 240 hr.; little resistance to current.	Cracked at 168 hr.; little resistance to current; some clear iron areas and some pitted.	700 lb.
10	Liquid glue.	Cracked at 240 hr. Passed large current; iron hydrate at top and around anode in concrete.	Cracked at 96 hr.; large current; dense iron hydrate on top. Bad corrosion.	100 lb.
11	Silicate of soda 20° Be. and graphite; equal weights.	Cracked at 144 hr.; considerable current, corrosion marked.	Cracked at 96 hr.; large current; corrosion marked.	Specimen faulty
12	Silicate of soda 20° Be. and iron oxide; equal weights.	Cracked at 240 hr.; considerable current.	Cracked at 192 hr.; considerable current.	1870 lb.
19	5% aqueous solution sodium resinate.	Cracked at 240 hr.; more current than unpainted.	Cracked at 144 hr.; considerable current.	1890 lb.
20	5% aqueous solution sodium resinate with equal weight iron oxide.	Cracked at end of 240 hr.; large current.	Cracked at 196 hr.; large current.	2580 lb.
	Lacquers			
7	Gum sandarac in alcohol, 32 oz. sol.	No cracking; only small current; no surface stain.	Only small current; no surface stain.	990 lb.
8	Gum shellac in alcohol. 32 oz. sol.	No cracking; small current; no stain.	Small current; slight surface stain.	490 lb.
18	Soluble nitrated cotton in amyl and ethyl acetate, 8-oz. sol.	Cracked at 240 hr.; large current; surface stain.	Cracked at 192 hr.; large current; surface stain.	2480 lb.
21	Gutta percha in benzol; 3 oz. sol.	Cracked at 240 hr.; considerable current; surface stain.	Cracked at 96 hr.; considerable current; considerable surface stain.	2600 lb.
26	Synthetic resin (phenol-formaldehyde) in alcohol.	Not used.	No cracking; small current; some surface stain and a small deposit of phenol-lime products.	1380 lb.
	Oils and Varnishes			
2	Heat-treated tung-oil compound in turpentine.	No cracking; specimen faulty; cathode exposed; very small current; film tough and elastic.	No cracking; moderate current; no stain.	2665 lb.
5	Double-boiled linseed oil (lead and manganese drier.)	Cracked at 140 hr.; considerable current; heavy surface stain.	Only a fine crack; considerable current; no stain.	1680 lb.
6	Kauri gum-linseed oil varnish.	Only slight crack; small current; no stain.	No cracking; no stain.	1790 lb.
9	Processed tung-oil compound.	No cracking; very small current; no stain.	No cracking; very small current; no stain.	1990 lb.
22	Equal parts of 9 and 21.	No cracking; small current; no stain.	No cracking; small current; no stain.	Specimen faulty

sheet-iron cathodes and water up to within 1 in. of their tops. The rods were connected in parallel and held for 240 hr. on 30 volts, after which time the voltage was increased to 55 and continued for 60 hr. The results were similar to the first series.

Tests of Bond—The third set of specimens was made up to duplicate the second, except that the rods were

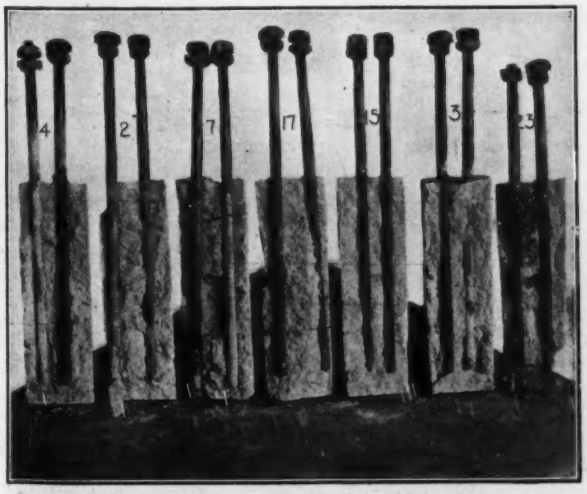


Test Specimens from First Series

placed flush with the bottom surface of the cylinder. After curing for three weeks, the rods were pushed through in a testing machine. These specimens were not subjected to electrolytic action.

General Results—The individual results are shown in the accompanying table. In general it was noted that where cracking occurred the anodes showed considerable rust and the original paint coatings were destroyed. The cathode bars of the first series of specimens showed intact paint coatings, except for chalky surfaces due to moisture and lime. Coatings on anode bars in uncracked cylinders were well preserved.

The breaking down of the paint film was shown by



Specimens Split after Test

a sharp rise in current and the sound of escaping hydrogen (identified with a lighted match). This gas seemed to have a softening action on some of the coatings and in escaping carried to the surface considerable quantities of oily products and iron oxide. Specimens giving this evidence of attack of the paint film by hydrogen also had the weakest bond between concrete and steel.

Some paints gave a good bond test, but failed as insulators; for instance, the water paints in No. 12, 19 and 20 and the lacquers in 18 and 21. Drying of some films to a flat surface is the explanation for good bond offered, except for the water paints which allowed some solvent action of the concrete. Most of the oil-pigment paints gave poor or only fair results, due to failure to dry hard and continued porous condition.

An Automatic Cab-Signal System for Stopping Trains

Another cab-signal system for automatically stopping a locomotive in the event of an overrun signal, etc., was tried out on Jan. 12, this time on a freight spur of the Long Island R.R., in the vicinity of Long Island City. The system came up to the inventor's expectations, the experimental train being stopped in all cases. The safety stop consisted of the usual two elements: (1) the stationary track apparatus and (2) the locomotive equipment. The latter consisted of (a) two contact shoes carried one on either side of the forward part of the engine, but insulated from the frame, (b) batteries, and (c) three relays controlling three solenoid-operated valves in the air line.

The first relay was operated in case of a break in the cab wiring or the track circuits (the latter due to a broken rail, etc.), and stopped the locomotive. The second relay operated a small whistle in the cab when the block ahead was occupied. The third relay stopped the engine when a second train was dangerously near the first.

With this system, the line is divided into blocks, whose lengths are determined by the railway engineers. In the case under test the block was about 2000 ft. long. The apparatus on each block comprises two short contact rails, one on each side of the track, and the necessary wiring. When the track is clear, the current in the track line is cut down by a 40-ohm resistance across the running rails. When the shoes first touch the contact rails, the first relay is energized. This opens the circuit of the first solenoid-operated valve, preventing its acting to stop the train. When the shoes mount the contact rails, two contacts on the upper part of the shoes close (see diagram) the circuit of the first solenoid. If there is no trouble or danger the circuit remains open, as the controlling relay has opened the line at another point. If, on the other hand, the track or cab circuits are opened in any way, the circuit of the first solenoid is not opened by its relay; this first valve admits air into two cylinders whose pistons close first the throttle and then throw on the emergency brake.

The whistle in the cab is operated when a train is some distance ahead in the next block, because the resistance of the electric circuit is reduced by the axles of the second train now in parallel with the 40-ohm resistance. This train does not short-circuit the track system because of the resistance of the rails between the two trains.

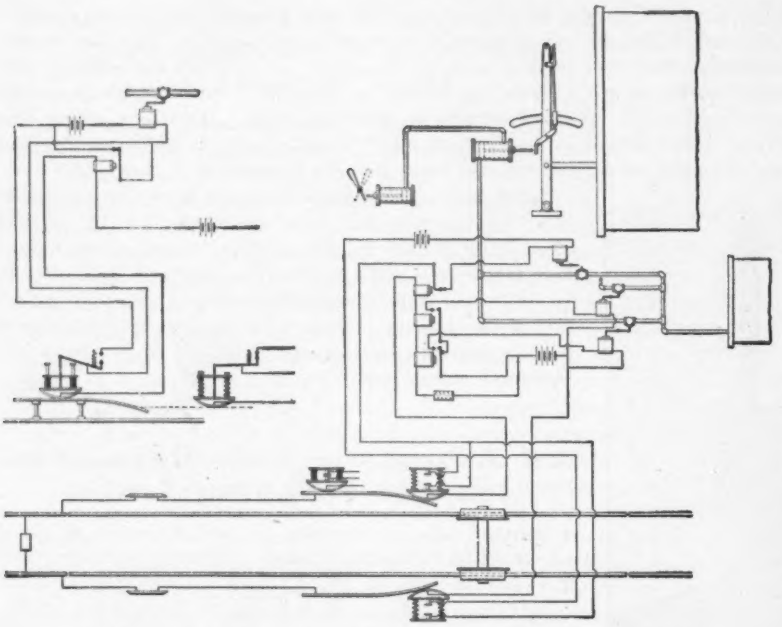


Diagram of Circuits of New Cab-Signal System

The third relay and solenoid are operated when the two trains are close enough together to cut out practically all resistance in the track circuits.

The relays are designed to operate at certain voltages; for instance, the first at 5 volts, the second at 10, and the third at 15. The voltage impressed on the relays is dependent upon the resistance of the circuit, this decreasing as two trains approach.

At the left of the accompanying diagram is shown the inventor's arrangement for closed-circuit operation. The air valve opens when its solenoid is not energized; the first relay holds the circuit closed unless the track lines are open by mischance.

With this system, when a train which should stop at a certain station runs by that station, it can be stopped by the station master throwing a small switch in his office to short-circuit a pair of contact rails placed at a convenient distance beyond the station. In the event of a track switch being open against a locomotive, the latter may be stopped if the opening of this switch is made to short-circuit contact rails placed at a certain distance in front of the switch.

This cab-signal system was invented by Antonio Casale, of 140 West 42d St. James B. Regan, proprietor of the Hotel Knickerbocker, is the principal promoter. At the Long Island tests, the railroad company was represented by A. B. Bierck, General Auditor, and L. S. Wells, Superintendent of Telegraph.

Impulse Wheels for 5000-Ft. Head, Lac Fully Plant

Some information on the notable Lac Fully water-power plant near Geneva, Switzerland, is given by Prof. F. Prásil in the "Schweizerische Bauzeitung" of Dec. 12, 1914. He sketches the general arrangement of the Pelton-wheel unit and of its discharge pipe or draft tube, as reproduced in our Figs. 1 and 2. The plant has five of these units, each of 3000 hp. Each wheel is direct-connected with a 10,000-volt 50-cycle alternator. The wheel is 11 ft. 7½ in. pitch diameter, and is built up of a cast-steel center and cast-steel buckets. The buckets are seated in a dovetailed slot in the periphery of the center. At nine points in the periphery the spacing wedges between the buckets are made deeper and seat in a notch in the wheel rim, the intermediate wedges being simply seated on the cylindrical surface.

The shaft bearings are respectively 8 and 9½ in. in bore and 24 in. long. They have oiling rings and pressure oiling. The nozzle has needle control and a swinging deflector plate for primary governing. The governing mechanism is shown, highly diagrammatically, in Fig. 3, which illustrates the relation of deflector-plate and needle governing. A centrifugal fly-ball governor is

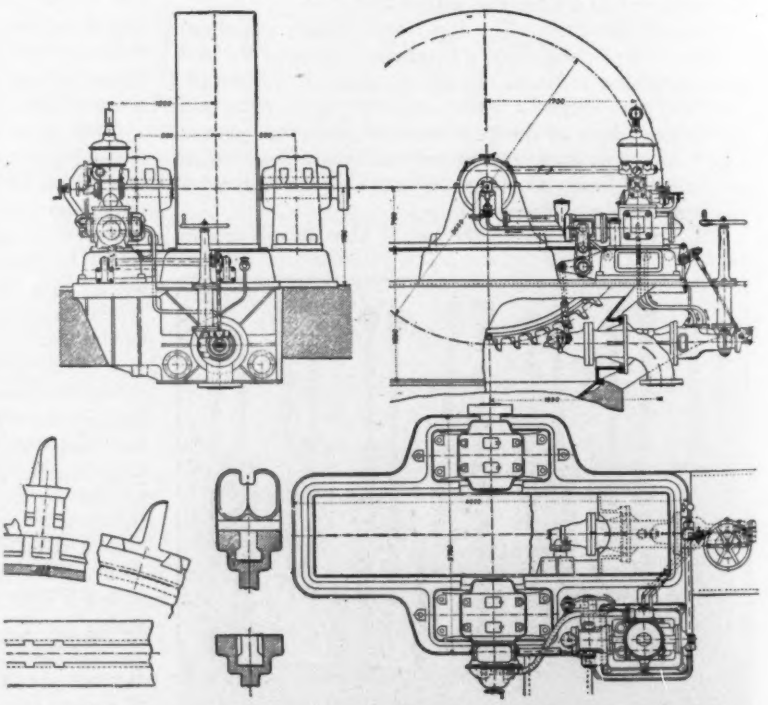


Fig. 1. General Drawing of Lac Fully 3000-Hp. Pelton Wheel for 5412-Ft. Head
(Dimensions in millimeters)

the controlling element and the movements are operated by hydraulic cylinders.

The head is 5412 ft., giving a nozzle velocity of nearly 600 ft. per sec. The wheel discharge has still a very high absolute velocity—about 20% of the original velocity—so that special care was needed to protect the discharge channel from erosion. A cast-iron and steel casing was provided in this channel as sketched in Fig. 2. The horizontal pipe into which it leads is dammed near its outer end to produce a water cushion which gives quiet outflow.

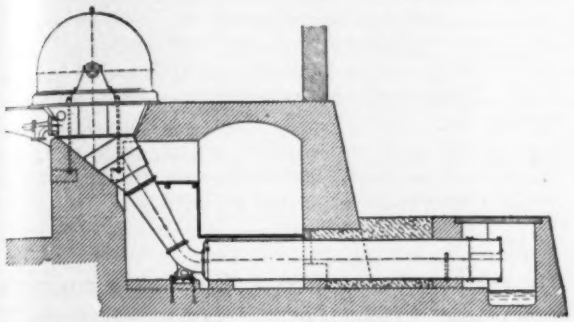


FIG. 2. WASTEWAY OF LAC FULLY WHEEL

Few data have yet been given on the supply piping and headwork details. The penstock ranges from 20 to 24 in. in diameter, with wall thickness ranging from ¼ to 1¾ in. Part of the piping is welded at longitudinal and ring-joints, while the heaviest sizes are made of seamless sections with welded ring-joints to form lengths which are then connected by packed loose-flange connections. The penstock is laid under a minimum depth of 3 ft. of earth cover.

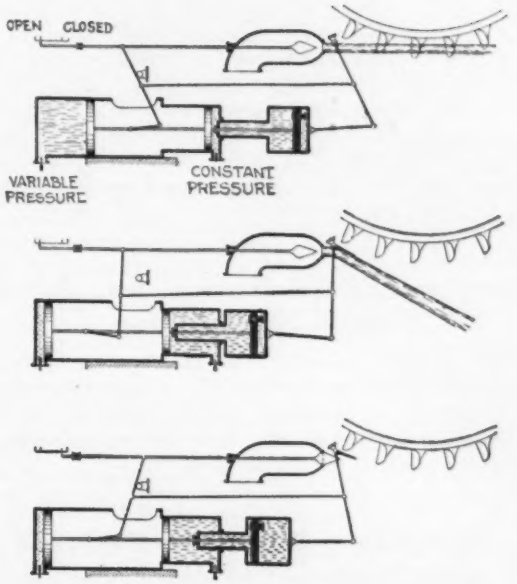


FIG. 3. DIAGRAMMATIC SKETCH OF GOVERNOR MECHANISM, LAC FULLY WHEEL

News of the Engineering World

City Planning for New York

The Committee on City Plan of New York is collecting fundamental data essential to an estimate of the future growth and requirements of the City of New York as related to a comprehensive plan of development for the city. The studies being made involve not only the development and revision of the general plan for the city, but also a study of the administrative and legal procedures necessary for carrying out such a plan.

The Committee on City Plan is a standing committee of the Board of Estimate and Apportionment appointed on the organization of the board after the new administration came into power in January, 1914. The committee consists of George McAneny, President of the Board of Aldermen, and the president of the five boroughs composing the city. The chief function of the committee is that of correlation. With that end in view the intention is that the Board of Estimate shall refer to this committee all the larger questions of public improvements which have a bearing upon the city plans.

For the purpose of studying such matters as the German zoning system, or the districting of a city for the purpose of regulating the height and character of buildings in different sections, the Committee on City Plan secured the appointment by the Board of Estimate of a separate Commission on Building Districts and Restrictions. The Committee on City Plan has itself appointed an Advisory Commission on City Plan consisting of 24 citizens, some of whom are, but most of whom are not, officials of the city. This commission will report on such matters as are referred to it by the Committee on City Plan and will assist the committee in the working out of a general plan of city development.

To coördinate the work of the Committee on City Plan and the Districting and Advisory Commissions the same staff is employed for all three, Robert H. Whitten serving as Secretary and Geo. B. Ford as Consultant. The offices are all in the Municipal Building, New York City.

The Earthquake in Central Italy

In a terrific earthquake which shook Latium, Campania and the Abruzzi Mountain regions, in Italy, on Jan. 14, more than 30,000 persons were killed and perhaps 50,000 injured. Falling buildings caused the greatest loss of life.

A portion of the ancient Claudian Aqueduct, near Rome, collapsed, and many structures were damaged in

Rome. The railway connecting the Capital with Aquila and Avezzano was put out of commission.

The earthquake is thought to be of geologic rather than volcanic origin. The first shock lasted about 30 sec. and in the succeeding three days more than 160 tremors were recorded on the seismograph at the observatory in Rome (Professor Palazzo, Chief); 49 occurred on Jan. 16. The region of the Abruzzi was shaken again on Jan. 17 for about 10 sec.

Structural Engineer vs. Architect in Illinois

The legislative committee of the Western Society of Engineers is seeking a definition of "structural engineer" in distinction to "architect." The definition should be concise but comprehensive. Answers from readers are requested (Monadnock Block, Chicago).

Booming Electric Service

A national "boost week" for electric service has been recommended to the Board of Directors of the Society for Electrical Development by representatives of numerous manufacturers, jobbers, contractors, supply dealers and utility companies. A big nation-wide campaign is advocated for some week this fall, during which time it is hoped to have all affiliated interests coöperate with manufacturers and various civic bodies to present the benefits of better lighting of streets, stores, factories and homes, in order to promote the use of all sorts of electrical appliances. If the society accepts the suggestion, a special committee will be appointed to take charge of the work under the direction of the general manager of the society, and local committees all over the country will handle the details.

Treatment of Chicago Stockyards Wastes

Experiments on the treatment of industrial wastes at the Chicago stockyards is the subject of a report made recently by George M. Wisner, Chief Engineer of the Sanitary District of Chicago. The work was under the direction of Langdon Pearse, Division Engineer. The object of the investigation was to determine the best means of abating the present local nuisance at the Bubbly Creek arm of the Chicago River and at the same time relieving the Chicago Drainage Canal of some of its burden of decomposable organic matter. The experiments included fine screening, sedimentation in Dortmund and Emscher or Imhoff tanks, chemical precipitation, sprinkling filters and sludge treatment.

The Federal statutes prohibit the discharge of settling solids into any navigable waters (or their tributaries), and under the state law the burden of preventing such discharge is put upon the industries which discharge waste or sewage into these waters. For about three years the problem at the Chicago stockyards and packing-house district has been under investigation, and for two years a sewage-testing station has been operated, the cost of this having been defrayed largely by a fund contributed by the companies interested.

The conclusions of the report are that fine screening can and should be done at each individual house or group of houses belonging to a firm, in addition to (and following) the skimming of grease from the waste. The screening should be supplemented by a sedimentation either at each home or at a central plant, the latter being preferable. Ultimately, biological treatment would be required. The estimated cost of screening and sedimentation, together with the recovery intercepting sewer, is $985,000 and of an extension of the sewer, a pumping station, sprinkling filters, secondary settling tanks and other collateral works, $3,600,000 additional. Neither estimate includes legal, engineering and land expenses.

Double-Tracking Susquehanna River Bridge at Harrisburg, C. V. R.R.

The Cumberland Valley R.R., part of the Pennsylvania System, will within a short time start work on a 46-span arch bridge 4000 ft. long to replace its present 25-span steel deck-truss bridge over the Susquehanna River at Harrisburg, Penn. The new bridge will cost approximately $750,000; its length will be the same as that of the Pennsylvania stone bridge over the Susquehanna at Rockville, just above Harrisburg.

The present bridge of the Cumberland Valley R.R. is single-track, while the proposed bridge will carry two tracks. It uses the present piers together with new piers, all being founded on rock. The new piers are already up above water level.

The old piers were built to provide for two tracks. By moving the tracks over to one side of the piers, operation of trains over the old bridge can be maintained while one-half of the new arch bridge is being constructed, and then traffic carried on the completed portion of the bridge until the other half is finished.

In connection with the construction of the new bridge, all grade crossings of the Cumberland Valley R.R. will be eliminated by depressing Front and Second St.

Flood Protection Work at Los Angeles, Calif., is under consideration, based upon a report dated June 3, 1914 (see "Eng. News," July 9, 1914, p. 95). Surveys are in progress with a view to detailing the actual work to be done, and a further report will be made later. Homer Hamlin is City Engineer.

The Shipping of Quarry Products in New England is now regulated by orders from the U. S. Department of Agriculture, which has decided that the eggs of the gipsy moth are frequently carried in this way. A quarantine has been placed on the infected districts of the New England States, which means that stone quarried in these districts cannot be moved to outside points until it has been inspected and passed by officers of the Department of Agriculture. The rules require that every car, box or other container of stone shall be plainly marked and bear a certificate of inspection. In the case of carload or bulk shipments, these certificates must accompany the way bills, conductors' manifests or bills of lading. Stone or quarry products originating outside the affected district can be shipped out from points within the quarantined area only under permit showing they are free from egg clusters. These permits are issued by the superintendent of moth work at Boston.

The Heaviest 24-hr. Rainfall at Boston since July, 1912, occurred on Wednesday, Jan. 13, the total for the day ending at 8 a.m. being 2.13 in. As 1914 was a very dry year in Massachusetts, the rain was seriously needed to replenish reservoirs. The precipitation accompanied a violent storm, with a wind

velocity as high as 75 mi. per hr. The wind caused an unusually high tide and considerable damage to roads, railroads and sea walls along the coast.

The Treatment of a Portion of the Sewage of Jersey City, N. J., is under consideration. The part of the city for which studies are being made is the section which drains into the Hackensack River. No funds are available for construction at present, but preparations are being made for field work looking to the drawing of plans and specifications. Geo. A. Johnson, consulting engineer, of New York City, and a resident of Jersey City, has been engaged as consulting engineer. Henry Byrne is Director of the Department of Streets and Public Improvements of Jersey City.

The O'Rourke Patent on Deep Foundation Construction, No. 678,581, dated July 16, 1901, has recently been passed on by the Federal court, as noted on p. 45 of our issue of Jan. 7. After that note was published, however, a decree of the court was handed down in which decree the Judge held claims 1 and 6 of the patent to be invalid but sustained claim 2, which reads as follows:

A plurality of caissons having removable and registering doors or wall sections in adjacent walls and having their adjacent walls secured together close to said removable doors or wall sections.

Claim 1, which was adjudged invalid, reads as follows:

A plurality of caissons having registering openings in adjacent walls of less area than the interior cross-section of the caisson and removable means for closing the openings substantially as described.

Repairs on the Dallas-Oak Cliff Viaduct at Dallas, Tex., injury to which by expansion of the wood-block paving on the roadway was described in our issue of Jan. 14, are to be undertaken immediately. The curbs and gutters most damaged are to be removed and replaced with new ones better bonded to the floor slabs. The remaining gutters and curbs will be secured by iron bolts grouted in place; and iron bolts, washers and brackets will be used to secure the cantilevers to the girders where cracks have occurred. New cantilevers and an outside girder will be built at the place where the principal failure occurred. A strip 2 in. wide was cut out of the wood-block paving along the west gutter the entire length of the viaduct immediately after the accident occurred, and this open space is to be filled with asphaltic cement to form an expansion joint. The work of repair is to be done by contract; bids were advertised for to be received on Jan. 21.

Rat-Proofing Work at New Orleans, La., covering all buildings in the city, and also including special work along the entire water front of some eight miles, is in progress. Early in January, 1915, a contract was let to rat-proof the Toulouse St. dock and shed. It is expected that other contracts will be let soon. In the water-front work, concrete walls will be built around sheds and warehouses and all openings that would give rats access to buildings will be stopped. Apparently a cutoff wall will also be built on the land side of the docks. The immediate cause for this work was some 20 cases of bubonic plague in New Orleans from June to October, 1914. The United States Public Health Service took charge of the situation. Among other things, it ordered that every dwelling house and place of business in the city be rat-proofed. Up to Jan. 1, 1915, about 7500 buildings had been rat-proofed, at a cost of $200 to $2500 per building.

Licenses for Engineers in Indiana are provided for in the draft of a bill presented at the annual meeting of the Indiana Engineering Society this week. The bill provides that no person may design, lay out or superintend or act as chief engineer of any work that may be classed as civil engineering work, or hold the office of city engineer, without obtaining a license from the State Board of Engineering Examiners. This board of three civil engineers would be appointed by the Governor and would hold regular examinations. The fee for taking the examination would be $25. Engineers engaged in practice at the passage of the law would receive a license without examination. The State Examining Board would also formulate examination questions for engineers employed as assistants, draftsmen, instrument men, inspectors, etc., and such examinations would be given by city engineers, county surveyors, or other designated persons. All engineers engaged on public work in subordinate capacities would be required to pass such an examination.

City Planning Commissions were established by 54 cities in the United States and one in Canada during 1914, according to a statement just published by the secretary of the National Conference on City Planning, Flavell Shurtleff, 19 Congress St., Boston, Mass. Thirty-two of these places are in Massachusetts, where, under a legislative act of 1913, all cities of the state and all the larger towns must appoint city planning commissions. Ten of the cities in the list are in Pennsylvania, three in New York and four in California, and four are scattering. The list as given by Mr. Shurtleff follows: Massachusetts—the cities of Adams, Beverly, Boston, Brockton, Cambridge, Chelsea, Chicopee, Everett, Gloucester, Holyoke, Lowell, Newburyport, Newton, Northampton, Malden, Medford, Melrose, Somerville, Springfield, Taunton, Waltham, Woburn, the towns of Brookline, Clinton, Framingham, Gardner, Plymouth, Wakefield, Watertown, Westfield, Weymouth, Winthrop; Pennsylvania—Chester, Easton, Erie, Harrisburg, Johnstown, Meadville, New Castle, Oil City, Reading, Wilkes-Barre, York; New York—Binghamton, Rome, Syracuse, Troy; California—Alameda, Berkeley, Oakland, San Francisco; scattering—Cumberland, Md.; Providence, R. I.; St. Paul, Minn.; West Hartford, Conn.; Canada—Swift Current, Sask.

A Rail Was Broken Into 74 Pieces in a derailment of a passenger train near Bigelow, Minn., on Feb. 9, 1914. The report of the investigation of this accident by the Interstate Commerce Commission has just appeared. The broken rail was 30 ft. long, weighed 80 lb. per yd., and had been in service over 13 years. The derailed train was running about 45 miles per hour. In passing over the broken rail, the forward pair of engine truck wheels and the rear pair of tender truck wheels were derailed, but the other locomotive wheels remained on the track until the engine came to a stop 1650 ft. beyond the point of derailment. All the cars in the train were derailed. Examinations of the broken rail by the Bureau of Standards and by James E. Howard, engineer-physicist, showed that the rail had a split head, the split extending nearly the whole length of the rail. Etched sections show that the web of the rail was badly streaked and laminated. To investigate further the causes of this class of rail failures, Mr. Howard examined 121 rails of 100-lb. weight recently removed from the track on account of fracture or incipient failure. Thirty-six of these rails had split heads, mashed ends or showed evidence of piping. The most serious thing about the split-head type of failure is that a rail with a split head gives no external evidence of its condition and may fail after a long period of service, as happened in the case of the rail above mentioned. The track where the derailment occurred was inspected on the day previous and a train passed over it only 50 minutes before the derailed train, showing conclusively that such serious rail failures as this can take place without previous warning. Mr. Howard traces this type of rail defect to interior streaks in the original ingot, probably due to the inclusion of slag. He says frankly that the rail mills hold out no encouragement that the production of occasional rails containing these defects can be prevented.

PERSONALS

Mr. C. A. Ashley has been appointed City Engineer of Naperville, Ill.

Mr. E. L. Gates, of Wheaton, Ill., has been appointed Superintendent of Highways of Du Page County, Ill.

Mr. Lewis W. Baldwin, Superintendent of the Louisville-Cairo division of the Illinois Central R.R., has been promoted to be General Superintendent.

Mr. C. S. Coe, M. Am. Soc. C. E., recently Division Engineer of the Key West extension of the Florida & East Coast R.R., has been appointed Engineer of Maintenance-of-Way.

Mr. Walter H. Gaither, former private secretary to Governor Tener, of Pennsylvania, has been appointed a member of the Pennsylvania State Public Service Commission.

Mr. Errett L. Callahan, Assoc. M. Am. Inst. E. E., Manager of the Business Department of H. M. Byllesby & Co., Chicago, has resigned to become District Manager of the Westinghouse Lamp Co., with office in Chicago.

Mr. Arthur H. Diamant, Assoc. M. Am. Soc. C. E., formerly Construction Engineer of Canavan Bros. Co., New York, has been made President and Managing Engineer of the Excavation & Foundation Co., Inc., New York.

Mr. Frank R. Devlin, a lawyer, has been appointed a member of the Railroad Commission of California, to fill the vacancy caused by the election of Mr. John M. Eshleman, former President of the Commission, as Lieutenant-Governor.

Mr. C. E. Stockdill has been appointed Assistant to the Vice-President and General Manager of the Canadian Pacific Ry., with office at Winnipeg, to succeed J. Manson, recently appointed Assistant to Vice-President, with office at Montreal, P. Q.

Mr. Thomas P. Riley, Judge of the Malden (Mass.) District Court, has been appointed a member of the Massachusetts Gas and Electric Light Commission, to fill the vacancy caused by the appointment to the chairmanship of Mr. Alonzo R. Weed.

Mr. H. B. McMaster, Commissioner for the Associated Metal Lath Manufacturers, at Youngstown, Ohio, has resigned to become Manager of Branches of the Berger Manufacturing Co. of Canton, Ohio. Mr. McMaster will enter upon his new duties Feb. 1.

Messrs. Hoey Chan-Chi, Yen Fung and Wen Han Hsen, three electrical engineers of Peking, China, are visiting the United States on their way home from England, where they were sent by the Chinese Bureau of Communications to study the street-car system of that country.

Mr. Henry D. Alexander, former Supervising Engineer, New York State Barge Canal, at Albany, N. Y., has been appointed Deputy Superintendent of Public Works of the State of New York by General Wotherspoon. Mr. Alexander is a graduate of Cornell University, class of 1893, and has had many years' experience in the Barge Canal service.

Mr. J. B. Berry, M. Am. Soc. C. E., and Mr. S. S. Roberts, M. Am. Soc. C. E., of Chicago, announce the dissolution of the firm of Berry, Howard & Roberts, and the continuance of the business under the firm name of Berry & Roberts, Consulting Civil Engineers, 1640 Transportation Building, Chicago. They will make a specialty of railway construction, improvement and valuation work.

Mr. F. M. Thomson, Assistant Engineer of the Houston & Texas Central Ry. at Ennis, Tex., has been appointed Assistant Superintendent of the El Paso division of the Galveston, Harrisburg & San Antonio Ry., with offices at El Paso, Tex. Mr. Thomson succeeds Mr. C. R. Morrill, who has been promoted to the Superintendency of the Second division of the Houston & Texas Central at Austin, Tex.

Mr. A. W. Newton, M. Am. Soc. C. E., has been made Assistant to the President of the Chicago, Burlington & Quincy R.R. Co. Mr. Newton entered the company's service in 1903, as Engineer of Construction on lines in the Missouri district. In 1903 he was appointed General Inspector of Permanent Ways and Structures at Chicago, and a year ago was made Chairman of the Committee on Valuation, in connection with which he was appointed on the Engineering Committee of the Presidents' Conference Committee on Valuation. Mr. Newton will continue his valuation duties in addition to those of his new position.

OBITUARY

Chauncey Ives, formerly Chief Engineer of the Cumberland Valley R.R., died recently at Hood River, Ore., where he was spending the winter. Mr. Ives, during recent years, has been located in New York City.

A. B. Hinkle, Assistant to the Division Engineer of the Chicago division of the Baltimore & Ohio R.R. Co., died on Jan. 2, at his home in Albion, Ind. Mr. Hinkle had been in the service of the company since 1885.

Frank W. Jenkins, for 52 years connected with the Henry R. Worthington Co., New York, died at his home in Brooklyn on Jan. 13, in his 83d year. Mr. Jenkins was born at Hudson, N. Y. He is survived by two daughters.

Alphonse Feldpauche, Secretary of the Association of Transportation Officers of the Pennsylvania R.R., died at Philadelphia on Jan. 5, at 66 years of age. He was formerly Chief Engineer of the Philadelphia, Wilmington & Baltimore R.R.

Arthur R. Lester, a railroad grading contractor, who for many years had been associated with Peter McGurk, died from apoplexy at his home in Denver, Colo., Dec. 27, aged 57 years. Mr. Lester had a part in the construction of many of the early railroads of the State of Colorado.

A. G. Jennings, of Joplin, Mo., a pioneer railroad contractor, died recently. He constructed the interurban lines in Joplin and in Wichita, and also built a part of the Kansas City Southern R.R. He was a subcontractor on the Atchison, Topeka & Santa Fé Ry. double-tracking.

Wilbur Warren Burroughs, a graduate of New Hampshire College and a native of Sanbornville, N. H., was drowned while skating at Tallulah Falls, Ga., Dec. 17. Mr. Burroughs had been located at Tallulah Falls as Chief Engineer of the Northern Construction Co. of Georgia.

St. George H. Cooke, a civil engineer, of Ridley Park, Penn., died recently at Fort Bayard, Silver City, N. M., at 31 years of age. Mr. Cooke had served five years as Captain of Company B, Engineers, of the National Guard of Pennsylvania. He is survived by a widow and three children.

Rowland T. Procter, Surveyor and County Highway Engineer of Jackson County, Mo., died at his home in Independence, on Jan. 6, after an illness of three years. He was born in Independence in 1862, had been county surveyor for six years, deputy county surveyor for several years, and city engineer of Independence for two years.

George A. Dalrymple, Superintendent of Road Work for the Revere Beach Division of the Metropolitan Park Commission, died Jan. 3 at his home in Revere, Mass., from pneumonia, aged 61 years. He was formerly Superintendent of Streets of Revere. He was a member of the Massachusetts Highway Superintendents' Association. Mr. Dalrymple was a native of Newton, Mass., and is survived by a widow and three children.

Barton Sewell, President of the Braden Copper Co., and Vice-President of the American Smelting & Refining Co., died at his home in New York City on Jan. 7, after an illness of seven months. He has long been prominent in the mining and smelting industry and took an active part in the lead industry of this country. Mr. Sewell was a veteran of the Civil War, and was in his 68th year. He is survived by a widow and two sons.

Christopher S. Gadsden, President of the Charleston & Savannah Ry. and Second Vice-President of the Atlantic Coast Line R.R., died in his native town of Summerville, S. C., on Jan. 12. Mr. Gadsden began his railway career in 1853 as a rodman with the engineering corps of the New Orleans Great Northern R.R. In 1900 he became President of the Charleston & Savannah Ry., and in 1902 was appointed Second Vice-President of the Atlantic Coast Line R.R.

James B. Alexander, a civil engineer, was found dead in his home in Minneapolis, Jan. 1. For many years Mr. Alexander was well known in railroad circles. During recent years he had lived the life of a recluse devoting his time to writing poetry and books on mysticism. He served as a civil engineer during the Civil War, and later became Division Engineer of the Northern Pacific and of the Great Northern Rys. Subsequently he had charge of construction of the Indiana, Bloomington & Western R.R., now part of the New York Central System. He was 83 years of age, and is survived by two brothers.

John Henry Clark, M. Am. Soc. M. E., for many years connected with the power and mining sales department of the General Electric Co., at Schenectady, N. Y., died at his home in that city, Jan. 3, after a short illness. Mr. Clark was born in Cornwall, England, in 1859. He had lived in Schenectady since 1895, coming from Boston, where he was connected with the General Electric Co.'s office. He served his apprenticeship with the Whittier Machine Co., of Boston, and was later its superintendent. For a time he was associated with Oliver Ames, former Governor of Massachusetts, in the development of an oil engine. He became connected with the Thomson-Houston Motor Co. in 1890, where he remained until it was merged with the General Electric Co. a few years later. He was a member of the Boston Engineers' Club and the Engineers' Club of New York. Mr. Clark is survived by a widow and three children.

Joseph McCabe, a railroad and tunnel contractor, died Jan. 3, at New Orleans, La., in his 59th year, while on a brief vacation through the South with his wife and daughter. He was born at Watertown, Wis., and after being educated in Milwaukee, commenced business life as a telegraph operator for the Chicago, Milwaukee & St. Paul Ry. He was later in the employ of the Northern Pacific and Great Northern Rys., rising steadily through various grades as Chief Dispatcher, Division Superintendent, finally becoming Vice-President and General Manager of the Washington & Columbia River Ry., a subsidiary of the Northern Pacific Ry. In 1906 he went to Rhode Island with Chas. S. Bihler, one of his construction engineers, and under the firm name of McCabe & Bihler built the New York, New Haven & Hartford R.R. tunnel under the East Side Hill at Providence, R. I. The partnership was dissolved in 1908, after which Mr. McCabe built the N. Y., N. H. & H. R.R. tunnel on the Highland division of the road between Waterbury and Hartford, Conn., rebuilt a difficult section of that line at Bristol, Conn., and returning to Providence in 1912, built the Rhode Island Co.'s street-railway tunnel under College Hill. He also built the difficult water-power tunnel under the N. Y., N. R. & H. R.R. power house at Cos Cob, Conn.

William A. Grondahl, a well known civil engineer of the Pacific Northwest, died Dec. 29, at his home in Portland, Ore. He was born in Christiania, Norway, Apr. 21, 1858, and educated at the technical school at Trondjhem. He came to this country at the age of 22 years and was first employed as draftsman on the St. Paul & Manitoba Ry. In 1881 Mr. Grondahl went to Oregon and served as Chief Draftsman for the old Oregon & California Ry., which later was merged with the Southern Pacific Ry. He was soon made Resident Engineer in charge of all construction between Portland, Ore., and Chestnut, Calif. Under his direction the line was completed through the Siskiyou Mountains and the Oregon and California ends of the line connected. In those days all structures were of timber construction, due to the cheapness of this material, and the prohibitive cost of steel. One of his noteworthy achievements was the construction of a wooden through Howe truss, with a 250-ft. clear span over the MacKenzie River, which at that time was claimed to be the longest Howe truss span in the world. He also designed the old Madison St. bridge at Portland and the highway bridge at Salem, Ore. In 1905 he was Division Engineer of the Spokane, Portland & Seattle Ry., having charge of the construction of the first 50 miles east of Portland. In this capacity he designed the reinforced-concrete structures built on the line. In later years Mr. Grondahl had been in consulting work, reporting on timber and reinforced-concrete designs especially.

ENGINEERING SOCIETIES

COMING MEETINGS

THE ENGINEERING FOUNDATION.
Jan. 27. Inauguration meeting in Engineering Societies building, New York City.

ILLINOIS SOCIETY OF ENGINEERS AND SURVEYORS.
January 27-29. Annual meeting at Springfield, Ill. Secy., E. E. R. Tratman, 1144 Monadnock Block, Chicago.

AMERICAN CONCRETE INSTITUTE.
Feb. 9-12. Convention at Chicago, Ill. Secy., E. E. Krauss, Harrison Bldg., Philadelphia, Penn.

CHICAGO CEMENT SHOW.
Feb. 10-17. At Chicago. Secy., J. P. Beck, Universal Portland Cement Co., Chicago.

AMERICAN CONCRETE PIPE ASSOCIATION.
Feb. 15-16. Annual convention at Chicago. Secy., E. S. Hanson, 538 South Clark St., Chicago, Ill.

IOWA ENGINEERING SOCIETY.
Feb. 17-19. Annual meeting; at Iowa City. Secy., S. M. Woodward, Iowa City, Iowa.

MINNESOTA SURVEYORS AND ENGINEERS SOCIETY.
Feb. 19-20. Annual meeting, at St. Paul, Minn. Secy., George H. Herrold, City Hall, St. Paul, Minn.

Society of Automobile Engineers—The officers elected for the ensuing year at the recent meeting are as follows: President, Wm. H. Van Dervoort; First Vice-President, F. R. Hutton; Second Vice-President, Joseph A. Anglada; Treasurer, Arthur B. Cumner.

Engineers' Club of Kansas City—The annual meeeting and dinner of the Club was held on Jan. 15. The officers elected for the ensuing year are as follows: President, J. W. Malcomson; First Vice-President, H. P. Treadway; Second Vice-President, G. C. Haydon; Secretary, E. B. Murray, 920 Walnut St.

Municipal Engineers of the City of New York—The annual meeting of the Society will be held at 29 West 39th St., New York City, on Jan. 27. After the usual business has been transacted, Prof. James F. Kemp, of Columbia University, will speak on "Cuba." The annual dinner was held on Jan. 16, at the Hotel Savoy.

North Dakota Society of Engineers—The seventh annual convention of the Society will be held at Minot, Feb. 4-5. Committee reports will be presented on legislation, concrete and concrete materials, roads, bridges, drainage, irrigation and other topics of an engineering nature. The Secretary is E. F. Chandler, University of North Dakota.

Colorado Association of Members of the American Society of Civil Engineers—At a regular meeting held on Jan. 9, at the Albany Hotel in Denver, a paper on "Unit Construction of Concrete Structures" was presented by Shirley Houghton, of San Francisco, Calif. Mr. Houghton also discussed the use of compressed air for carrying concrete from the mixer in tunnel work. The Secretary is Roger W. Toll, 700 Tramway Bldg., Denver, Colo.

Pacific Northwest Society of Engineers—At the annual meeting of the Society, the following officers were elected: President, Marvin Chase, Richmond, Wash.; First Vice-President, D. W. McMorris; Second Vice-President, A. P. Denton, Third Vice-President, A. S. Downey; Secretary, Jesse A. Jackson, 312 Central Bldg., Seattle, Wash. The program included discussions of the relationship of business to engineering, the public service of the engineer and engineering problems of the West as compared with those of the East.

American Society of Engineering Contractors—At the annual meeting of the American Society of Engineering Contractors, held at the Engineering Societies Building on Jan. 15, the election of Hillis F. Hackedorn to the Presidency was confirmed.. Mr. J. R. Wemlinger was reëlected Secretary. As there was not a quorum, discussion of the various matters relating to the welfare of the Society was informal. The annual banquet at Bustanoby's in the evening was attended by about 100 members and guests. It was enlivened by a cabaret and moving pictures.

Western Society of Engineers—The annual meeting and dinner were held at the La Salle Hotel, Chicago, Jan. 13. On the following day there was a trip by special train to the new valve and pipe-fitting plant of the Crane Co., the interchange yard of the Chicago & Western Indiana R.R. at Clearing, and the mail-order and manufacturing plant of the Sears-Roebuck Co. In the evening a "smoker" was held at the Society's rooms, where an illustrated address was given on the two California exhibitions (at San Francisco and San Diego). The officers for 1915 are as follows and are all located in Chicago: President, William B. Jackson; Vice-Presidents, Ernest McCullough, Charles B. Burdick, P. B. Woodworth; Treasurer, C. R. Dart; Secretary, J. H. Warder.

Colonel George W. Goethals will be the guest of honor at a joint luncheon of the Western Society of Engineers and the Chicago Engineers' Club at the La Salle Hotel, on Jan. 22. W. H. Finley, a past-president of both engineering societies, will preside and introduce the guest.

New England Water-Works Association—The annual meeting was held in Boston on Jan. 13. After an informal reception and a luncheon at the Hotel Brunswick, Desmond FitzGerald showed a number of colored lantern slides of travel.

Dr. Allen J. McLaughlin, the new State Health Commissioner of Massachusetts, was the guest of the Association. In response to a request for a speech, he talked briefly about the need of constant care in the operation of water-purification works and of the desirability of supplementary chemical treatment of filtered waters. He expressed the feeling that all engineers and water-works superintendents are really health officers.

The Association increased its membership from 758 to 847 during 1914, a very good gain in view of the hard times. The retiring President, F. I. McInnes, addressed the Association and made recommendations based on his experiences, placing special weight on the desirability that papers be read only in abstract when they have previously been printed and issued to members, a recommendation with which those who were in attendance at the last annual convention will agree.

The Committee on Filter Statistics, consisting of George C. Whipple, Chairman; F. D. West, E. E. Lockridge, R. S. Weston and F. W. Green, presented its report and recommended that discussion be reserved for the February meeting.

The results of the recent letter ballot for officers were announced. Leonard Metcalf, consulting engineer, Boston, was elected President.

American Concrete Institute—The 11th annual convention of the Institute will be held in Chicago, Feb. 9-12, with headquarters at the Auditorium Hotel. Among the papers to be presented are the following:

"Present Practice in Concrete Road Construction," Percy H. Wilson, Philadelphia, Penn.; "The Experimental Concrete Road in Philadelphia," William H. Connell, Chief, Bureau of Highways, Philadelphia, Penn.; "Reinforcing Narrow Concrete Roads," John Mueller, New Castle, Ind.; "Comparative Cost of Concrete Roads," Percy H. Wilson; "Cost of Construction and Maintenance of Concrete Roads," H. J. Kuelling, County Highway Commissioner, Milwaukee, Wis.; "The Construction of Integral Curbs," Charles E. Russell, City Engineer, Highland Park, Ill.; "Organization and Methods of Constructing Concrete Roads," William Acheson, Division Engineer, New York State Highway Commission, Buffalo, N. Y.; "Tests of a Reinforced-Slab Bridge," E. B. McCormick, Mechanical Engineer, Office of Public Roads, Washington, D. C.; "Design of Wall Columns and Wall Beams," Sanford E. Thompson, Newton Highlands, Mass.; "Reinforced-Concrete Stands, Stadiums and Bowls," Charles W. Leavitt, Jr., New York, N. Y.; "Design of Concrete Bins for the Storage of Cement," Leonard Wesson, Universal Portland Cement Co., Chicago, Ill.; "A Critical Review of Current Practice in Reinforced Concrete as Embodied in Building Regulations and the Joint-Committee Report," Edward Godfrey, Pittsburgh, Penn.; "Design of Reinforced-Concrete Structures," C. A. P. Turner, Minneapolis, Minn.; "Report of Committee on Edison Fire," Cass Gilbert, Chairman; "Contractor's Equipment, Austin-Nichols Warehouse," T. A. Smith, New York City; "Mechanical Plant for Handling Concrete," Wm. P. Anderson, Ferro Concrete Construction Co., Cincinnati, Ohio; "Strength of Concrete Forms," Harrison B. Taft, Contracting Engineer, Seattle, Wash.; "Design and Construction of the Massachusetts Institute of Technology Buildings," Sanford E. Thompson.

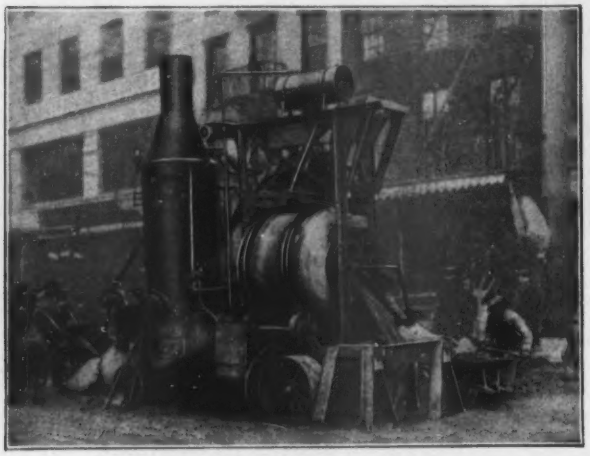
American Water Works Association—The 35th annual convention will be held in Cincinnati, Ohio, May 10-14, with headquarters at the Hotel Gibson. One of the days has been set apart as "Superintendents' Day," when the question box will be discussed, as well as general water-works topics. Superintendents should send in questions for discussion as early as possible, and prepare papers based on experiences and new methods. Papers to be printed in the March "Journal" must be received not later than Feb. 1. The Secretary is J. M. Diven, 47 State St., Troy, N. Y.

Appliances and Materials

A Heater for Concrete Mixers

A special attachment for heating concrete materials in the mixer has just been put on the market by the Koehring Machine Co. The accompanying view shows a mixer equipped with the heater, at work on the 7th Ave. subway construction, New York City (U. S. Realty Co. contract).

This attachment, which is a development of the Koehring hot mixer used in asphalt work, consists of a brick-lined combustion chamber heated by an oil flame through which air



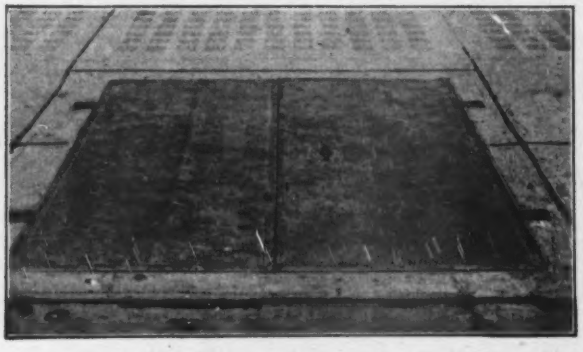
HEATER FOR CONCRETE MIXER

is forced by a blower. The heated air and products of combustion pass into the drum of the mixer. When a steam-engine drive is used on the mixer, a steam pipe connection heats the mixing water, but with motor drive, no additional water heating is available. It has been found that a frozen piece of sand and gravel will be heated to a comfortable warmth from the hot-air blast alone in less than a minute. The mixer shown is the regular end-feed paving type; the fuel-oil storage tank is on the top of the frame.

* * *

Nonslip Sidewalk Trapdoor

The well known slipperiness of the ordinary steel trapdoor for covering sidewalk areaways has led to the production of a sidewalk door of steel, having its upper face covered with a three-ply layer of canvas, riveted on. The edges of the steel plate are turned up to protect the can[illegible] The general appearance of the door is shown by the accompanying view. The door has been patented and is controlled by the Non-Slip Sidewalk Door Co., of Spokane, Wash., of which D. C. Coates, ex-Commissioner, Department of Public Safety, is President. A number of the doors are in use in Spokane and except for concrete-surfaced doors, no other kind of sidewalk doors are permitted in that city.

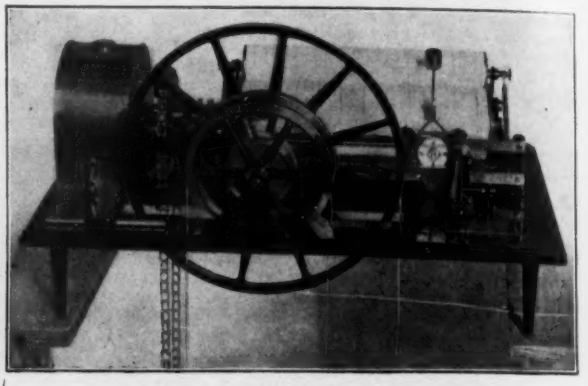


NONSLIP SIDEWALK TRAPDOOR

* * *

Stevens' Differential Water-Stage Recorder

The continuous water-stage recorder designed by J. F. Stevens (and described in "Engineering News," July 25, 1912) has been adapted to a differential type for showing net difference in water level of two distinct bodies for power or pumping plants, filter beds, locks, submerged weirs, etc. The chart drums and pencil carriage remain as before (including the feature of reversing pencil travel when the chart edge is



DIFFERENTIAL WATER-STAGE RECORDER

reached so that any rise or fall is shown on a limited chart width without reduction of scale).

In place of the simple float pulley, on the spine-wheel shaft governing the carriage travel, there are two sheaves over which run light bronze cables leading to counter-poised floats on the two bodies of water. These are connected by differential gearing so that the shaft supporting them moves proportionately to the difference in their peripheral travel. The clock spring has been replaced with a weight on a sprocket chain; winding is required only once in six months.

The horizontal difference between the two floats should not be over 100 ft. unless the cables can be supported every 20 ft. to eliminate sag. Whenever this limit is exceeded, recourse must be had to the long-distance reporting attachment described in this column, Jan. 14, 1914. This device has been patented by J. F. Stevens, Consulting Engineer, Portland, Ore., and is being made by Leupold, Voelpel & Co., of Portland.

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A New Goulds Centrifugal Pump

A new line of single-stage single-suction inclosed-impeller pumps has been put out by the Goulds Mfg. Co., of Seneca Falls, N. Y., to meet a demand experienced for a higher-efficiency moderate-priced unit. The line has five sizes giving a capacity range of 80 to 1000 gal. per min. It is designed especially for direct connection to electric motors, though not limited to that service, and the units vary in speed from 750 to 1950 r.p.m. depending on head and capacity. A single casting forms the base, and supports the two bearings of the impeller shaft and the volute casing. The outboard bearing is a heavy split babbitted ring-oiling type, while the inner one is a water-lubricated bronze bushing, between the overhung impeller and the stuffing box. The volute casing is held to a vertical circular machined seat by eight bolts, so that it can be turned to give eight positions of the discharge connection.

* * *

Electric Industrial Locomotive

A new design of industrial electric locomotive has been put out by the Orenstein-Arthur Koppel Co., of Koppel, Penn., having a double truck for service on tracks where sharp curves are necessary (down to 12-ft. radius). Small wheels have been used to keep the wheel base short and to allow a double truck with the same size frame formerly used with a single truck. The motor is mounted on the frame and the wheels are driven by a silent chain. A pantograph trolley has been used in place of the pole.